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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. X.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

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DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY

ONE OF THE NATURALISTS OF THE EXPEDITION

PRESENTED BY THE NAVY

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ZOOLOGY—VOL. X.

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ERRATA.

Report on the Nudibranchiata (Part XXVI.).

Page 16, line 8 from foot, *for* "Atlantic" *read* "Pacific."
Page 31, at top, *insert* "Family Scyllæadæ."
Page 34, line 9, *insert* "Family Bornellidæ."
Explanation of Plate IV. fig. 5, *for* "in interior of, &c.," *read* "of the everted part of the glans."

Report on the Polyzoa (Part XXX.).

Page 4, line 3 from top, *for* "*Tubalipora*" *read* "*Tubulipora*."
Page 29, line 13 from foot, *for* "*Cabarea*" *read* "*Caberea*."
Page 34, line 4 from top, *for* "*spatulata*" *read* "*pectogemma*."
Page 35, line 8 from top, *for* "*spatulata*" *read* "*pectogemma*."
Page 165, line 9 from foot, *for* "Oberoligacäns" *read* "Oberoligocäns.'
Page 165, line 8 from foot, *for* "Castracaro" *read* "Castrocaro."
Page 168, line 9 from foot, *for* "*Forficala*" *read* "*Forficula*."
Page 194, line 16 from top, *insert* "Pl. XXX. fig. 2."
Page 195, line 3 from foot, *insert* "Pl. XXXV. fig. 19."
Plate II. fig. 4, *for* "*cirratæ*" *read* "*cirrata*."
Plate XXXII. fig. 3, *for* "*Calymophora*" *read* "*Calymmophora*.'

EDITORIAL NOTES.

This volume contains Parts XXVI., XXVII., XXVIII., XXIX., and XXX. of the Zoological Series of Reports on the Scientific Results of the Expedition.

Part XXVI.—Dr. Rudolph Bergh of Copenhagen, who is well known to Naturalists from his numerous Papers on the Nudibranchiata, undertook the description of the specimens belonging to that group collected by the Expedition, and this Memoir gives the result of his investigations. The Manuscript was received on the 7th July 1883—partly written in English and partly in German—the latter being translated into English by the Naturalists on the Editorial Staff.

Part XXVII.—The Manuscript of the Report on the Myzostomida, by Professor L. von Graff, was received on the 11th October 1883. Dr. von Graff has, by introducing references to the original descriptions of the few species not collected by the Expedition, rendered this Report a complete Monograph of this interesting group of animals.

Part XXVIII.—The Systematic Part of the Report on the Cirripedia, by Dr. P. P. C. Hoek, was published as Part XIX. of the Zoological Series of Reports on the Scientific Results of the Expedition.

The present Memoir is a Supplementary Report by the same author, and deals with certain points in the anatomy of the group. The Manuscript of this second part was received on the 1st May 1884.

Part XXIX.—This Paper is the first part of a Report, by Professor William Turner, F.R.S., on the Bones of the HUMAN SKELETONS collected by the Expedition, and deals with the CRANIA. Professor Turner has not limited the Report to a description of the CRANIA actually collected by the Expedition, but has examined along with them numerous skulls from other collections, and has drawn certain general conclusions bearing on the Ethnology of the races. The Manuscript containing the descriptions of the CRANIA was received in July 1883, whilst the last two chapters referring to the general conclusions were received in July 1884.

Part XXX.—Shortly after the return of the Expedition to England, George Busk, Esq., F.R.S., consented to prepare a Report on the collection of POLYZOA.

The present Memoir is the first instalment of the Report, and treats of the CHEILOSTOMATA. The Manuscript was received in batches between the 7th February 1883 and the 16th July 1884. Mr. Busk promises the second and concluding part of his Report in the course of a few months.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, *24th September* 1884.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the NUDIBRANCHIATA dredged by H.M.S. Challenger during the years 1873-1876. By Dr. RUDOLPH BERGH, Physician to the General Hospital of Copenhagen.

JUDGING from the number and variety of the species of Nudibranchiata that have been hitherto described from the shores of the tropical seas, it is probable that this part of the world will ultimately prove to be the headquarters of the group. Although up to the present the tropical Nudibranchiata have been but slightly examined in comparison with the northern species, nearly every exploring expedition that has visited the tropics has discovered new and interesting forms of these animals. The Families of the Nudibranchiata are by no means evenly distributed in the different oceans. Of the Æolidiadæ by far the greatest number of species inhabit the northern seas, and only a few species have been described by van Hasselt, Kelaart, Alder and Hancock, Collingwood, Semper, and others, as occurring in the tropical seas.[1] On the other hand, the large and important Family Doridiadæ is more abundantly represented both generically and specifically in the tropics.

Since the main object of the Challenger Expedition was the investigation of the deep sea, the number of dredgings made in shallow water was comparatively few; accordingly, as might have been expected, the number of Nudibranchiata collected during the voyage

[1] Van Hasselt only discovered three species, Elliot four or five, Kelaart nine, and Semper four.

Collingwood (Observations on the distribution of some species of Nudibranchiate Mollusca in the China seas. *Ann. and Mag. Nat. Hist.*, ser. 4, vol. i., 1868, pp. 90–94) calls attention to the scarcity of Nudibranchiata on the shores of China, Formosa, Labuan, and Singapore, with respect both to the number of species and of individuals, and contrasts with this the comparative abundance of the group on the English shores. Among the Nudibranchiata collected by Collingwood there was not a single representative of the Family Æolidiadæ.

was not large. The Challenger collection contains altogether twenty-five species, including one deep-sea form of the greatest interest (*Bathydoris abyssorum*).

The following is a list of the species:—

1. *Phylliroë atlantica*, Bergh.
2. *Acura pelagica*, Adams.
3. *Acura lanceolata*, Bergh.
4. *Fiona marina*, Forskål.
5. *Glaucus atlanticus*, Forster.
6. *Janolus australis*, n. gen. and sp.
7. *Cuthonella abyssicola*, n. gen. and sp.
8. *Rizzolia australis*, n. sp.
9. *Scyllæa pelagica*, Linné.
10. *Bornella excepta*, n. sp.
11. *Tritonia challengeriana*, n. sp.
12. *Marionia occidentalis*, n. sp.
13. *Ohola pacifica*, Bergh.
14. *Euplocamus pacificus*, Bergh.
15. *Chromodoris striatella*, Bergh.
16. *Chromodoris rimcinata*, Bergh.
17. *Ceratosoma cornigerum*, Adams.
18. *Archidoris kerguelenensis*, n. sp.
19. *Archidoris australis*, n. sp.
20. *Discodoris morphæa*, Bergh.
21. *Platydoris eurychlamys*, Bergh.
22. *Thordisa clandestina*, n. sp.
23. *Bathydoris abyssorum*, n. gen. and sp.
24. *Doriopsis nebulosa*, Pease.
25. *Onchidium melanopneumon*, n. sp.

I. Order.—NUDIBRANCHIATA KLADOHEPATICA.

The majority of the forms belonging to this Order which were collected during the expedition are pelagic (*Phylliroë*, *Acura*, *Glaucus*, *Fiona*), some are littoral (*Rizzolia*, *Janolus*), but only one genus (*Cuthonella* [1]) was obtained from the deep sea.

The genera *Scyllæa*, *Bornella*, *Tritonia*, and *Marionia* are transitional between the kladohepatic and holohepatic Nudibranchs.

[1] Up to the present time but one species belonging to the Family Æolidiadæ has been found in deep water—*Goniaolis typica*; this was dredged by M. Sars, at a depth of from 70 to 100 fathoms.—(G. O. Sars, On some remarkable forms of animal life from the great deeps off the Norwegian Coast, part 1, pp. 39–40, Christiania, 1872).

Family PHYLLIROIDÆ.

Psilosomata, Blainville, Manuel de Malacol., 1825, p. 484.
Phylliroidæ, Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft v., 1873, pp. 210–246.

Corpus magnopere compressum, altum; postice nonnihil humilius in caudam compressam apice truncatam, vel gradatim attenuatam abiens; antice collo cum capite quasi boviformi conjunctum. Caput sat magnum, rhinophoriis contractilibus, pro parte vaginis retractilibus, simplicibus, elongatis instructum; tentacula nulla.

Bulbus pharyngeus fortis, illi *Pleurophyllidiarum* non dissimilis, ita quoque mandibulæ fortes. Linguæ radula non pauciseriata; dens medianus utrinque denticulatus; dentes laterales non multi, utrinque denticulati.

Glandulæ hermaphrodisiacæ discretæ 3; glans penis conulis armata.

These remarkable pelagic animals were placed among the Pteropoda by the earlier observers (Péron, Lesueur, Blainville); by other systematists (Lamarck, Cuvier, A. d'Orbigny, Cantraine, van der Hoeven, H. and A. Adams) they were incorporated with the Heteropoda; they were transferred to the Salpæ by Rang. Eydoux and Souleyet first clearly showed them to be "nudibranchiate" Gasteropoda, though their affinity with the Gasteropoda had been previously hinted at by Eschscholtz.

This Family contains two genera, *Phylliroë* and *Acura*, if indeed these be really distinct. Numerous memoirs have been published upon the former genus, but the structure of *Acura* was first made known through my Monograph.

The Phylliroidæ have a very remarkable form. The body is high and laterally very compressed; at the posterior end it is lower and passes into a tail, which is either long and filiform (*Acura*), or similar in shape to the body and truncated at its extremity (*Phylliroë*); the head, which is separated from the body by a more or less strongly pronounced "neck," is large and strong and somewhat high; its shape is peculiar, owing to the presence (*Phylliroë bucephala*) of elongated simple *rhinophoria*, which can be retracted into their wide sheaths; there is no trace of any tentacula.

The *bulbus pharyngeus* is very strong and rather high, resembling closely the bulbus of the Pleurophyllidiadæ; the mandibles are rather powerful, somewhat resembling those of the Pleurophyllidiadæ, the cutting edge is densely covered with fine prominences like the teeth of a comb. The small "tongue" is entirely enclosed within the buccal cavity; the radula is made up of an inconsiderable number of thin teeth. On either side of the median tooth, which is finely denticulated on both sides, are usually six lateral teeth, unsymmetrically denticulated on both sides. The *liver* consists of four long cœca, two superior and two inferior. The *kidney* is a long sac, opening internally into the pericardium through the renal syrinx, and externally by a short ureter on the middle of the body. The *hermaphrodite gland* consists of several—usually three—isolated lobes. The *penis*

is very large, the glans covered with small rather soft cones; at the base of the glans is a peculiar wing-like process (*check-wing*).

Phylliroë, Péron et Lesueur.

Phylliroë, Péron et Lesueur, Ann. du Muséum, t. xv., 1810, p. 65, pl. ii. figs. 1–3.
„ Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft v., 1873, p. 210.
Eurydice, Eschscholtz, Isis, 1825, I. col. 737, Taf. v. fig. 6.
Philyrine, Menke, Zeitschr. f. Malacozool., 1844, p. 73.

Cauda corporis postice truncata.

Phylliroë differs from *Acura* in having a short truncated tail. The string-shaped spawn of several species is known, as well as the early stages of development.[1]

Several species of this genus, chiefly from the open sea, have been described; most of them, however, will in all probability turn out eventually to be identical,[2] and perhaps the majority are circumæquatorial. I have examined individuals from the Indian Ocean which appeared to be identical with the common Atlantic form.[3]

1. *Phylliroë bucephala*, Péron et Lesueur.
   Mediterranean, Atlantic.

2. *Phylliroë atlantica*, Bergh.
   Atlantic, Indian Ocean.

3. *Phylliroë rosea*, d'Orbigny.
   Pacific.

4. *Phylliroë lichtensteinii*, Eschscholtz.
   Pacific (near Sandwich Islands).

5. *Phylliroë punctulata*, Quoy et Gaimard.
   Pacific.

6. *Phylliroë rubra*, Quoy et Gaimard.
   Indian Ocean.

7. *Phylliroë amboinensis*, Quoy et Gaimard.
   Bergh, *loc. cit.*, pp. 236–241, Taf. xxix. figs. 16–21, Taf. xxx. figs. 2–5.
   Indian Ocean, Philippines.

[1] A. Schneider, Ueber die Entwickelung der Phyllirhoë bucephalum, *Archiv f. Anat. u. Physiol.*, 1858, pp. 35–37, Taf. iii. A.

[2] MacDonald, *Ann. and Mag. Nat. Hist.*, ser. 2, vol. xv., 1855, pp. 457–460.

[3] Bergh, *loc. cit.*, pp. 229–231.

[4] The bracket indicates my opinion that the species thus connected are more closely related than the others; perhaps even varieties of one species.

Phylliroë atlantica, Bergh.

Phylliroë bucephala, Souleyet, Voy. de la Bonite, Zool., ii., 1852, p. 399–415, pl. xxxv. figs. 1–18.[1]

atlantica, Bergh, Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxi., 1871, pp. 1302–1305.

Malacolog. Untersuch., *loc. cit.*, pp. 212–231, Taf. xxviii. figs. 1–18, xxix. figs. 1–15, xxx. fig. 1, xxxi. figs. 1–2.

Sacci hepatici posteriores medio non coarctati. Glandulæ hermaphrodisiacæ paginâ inferiore castaneæ.

This species differs from that of the Mediterranean in the absence of the constriction[2] in the middle of the posterior hepatic sacs, and in the chestnut-brown colour of the underside of the hermaphrodite glands.

A series of thirteen individuals was taken on the surface in the Atlantic near the coast of Africa, 16th August 1873, and off St. Vincent, Cape Verde Islands, 26th April 1876.

Most of the specimens were well preserved and of medium size, the length averaging 12 mm. (without the rhinophoria), and the height 9 mm.; a few were smaller, not measuring more than 8·5 mm. in length. The colour quite as usual.

The form of the animals and the structure of the organs of the body agree perfectly with the previously examined specimens.

The *central nervous system* has been already described by me. H. von Jhering[3] considers that the upper pair of ganglia represent the cerebral, and the lower pair the pleuropedal (visceropedal). I do not believe this interpretation to be right, since the upper ganglia sometimes exhibit a very marked line of division into two parts, and occasionally the upper commissure between the two ganglia is distinctly double, which appears to indicate a separate connection between the two cerebral on the one hand, and the two pleural ganglia on the other. The upper ganglia give off two strong nerves to the walls of the upper part of the body. The visceral commissure certainly in most cases appears to be derived from the inferior ganglia, but the same is the case with the sub-cerebral commissure, which nevertheless has its origin in the upper ganglia. The genital nerve, described by von Jhering, is not the true *nervus genitalis* but the right *nervus pediaeus* (*longus*), which, passing between the windings of the spermatic duct, extends along the walls of the lower part of the body. The true *nervus genitalis* does not seem to be derived from the inferior ganglia. I never saw the commissures uniting the inferior ganglia quite so distinct from each other as von Jhering[4] figures them; the visceral commissure was always free, but the other two

[1] The true *Phylliroë bucephala* of Lesueur and Péron inhabits the Mediterranean (Bergh, *loc. cit.*, p. 231).

[2] In two small individuals, measuring 5 to 6 mm. in length, the underside of the glands was not coloured, and the hepatic sacs had several constrictions. Are these specimens really *Phylliroë bucephala*? (Bergh, *loc. cit.*, p. 235).

[3] Vergl. Anat. d. Nervensyst. d. Moll., Leipzig, 1877, pp. 185–189.

[4] *Loc. cit.*, Taf. ii. fig. 5.

were either fused throughout their whole length, or merely separate at the point of origin. The *eyes* presented no peculiarities of structure. The *otocysts* were considerably larger than the eyes, and were visible in all the specimens examined as chalk-white points of about 0·1 mm. in diameter. In one specimen they were distinctly seen to contain about 100 otoconia of the usual appearance, the largest measuring about 0·013 mm. The structure of the skin, together with its peculiar phosphorescent cells ("cells of Müller," Panceri) has been already described by me.

The *bulbus pharyngeus*, the *mandibles*, and the *tongue* have been already described by me. I made a careful examination of the number of rows of teeth in the radula of three individuals, and found that they were provided with eleven, fourteen, and sixteen respectively. Further back, within the sheath of the radula, there were from three to five fully developed, and two undeveloped series. The total number of rows in the three individuals was therefore eighteen, twenty, and twenty-six respectively. As is usually the case, the oldest (most anterior) row consisted only of a single lateral tooth on either side of the median tooth, and this arrangement (1–1–1) seems to be the original form of the armature of the tongue in the young of these animals. The number of teeth then gradually increases to six or seven. The shape of the teeth was quite typical.

With respect to the *renal organ*, I have nothing to add to my former description.

The *hermaphrodite glands* (in the three specimens examined) were three in number. The ampulla of the hermaphrodite duct and the vas deferens I have already described. In all three specimens the *penis* was invaginated. Behind the middle of the organ there is a lateral prominence, through the wall of which was visible a strong cylindrical or conical organ; behind this, again, a number of fine, whitish, densely set points. When the organ was opened this conical or sometimes wing-shaped prominence was seen to project freely into its interior.[1]. With the exception of that portion behind the wing-shaped lateral prominence, where are developed the small cones, the cavity of the penis is smooth and often presents circular folds. The function of this wing-shaped prominence would appear to be to prevent the male organ from being introduced too far into the vagina. Gegenbaur,[2] however, and H. Müller, consider that it serves to fix the organ during copulation, and it cannot be denied that its structure[3] would fit it for this purpose. A portion of the mucous gland in the neighbourhood of the female genital opening, which is of a more yellowish colour, possibly represents the albuminiparous gland. The spermatheca is absent.

[1] Bergh, Malacolog Untersuch., *loc. cit.*, pp. 227, 228, Taf. xxix. fig. 13*a*; xxvii. figs. 21, 22; xxxi. fig. 4*c*; xlv. figs. 1–4.

[2] *Zeitschr. f. wiss. Zool.*, Bd. v., 1854, p. 356.

[3] Bergh, *loc. cit.*, p. 228.

Acura, H. and A. Adams.

Acura, H. and A. Adams, Genera of recent mollusca, vol. ii., 1858 (part ix., 1855), p. 98.
„ Bergh, Malacolog. Untersuch., *loc. cit.*, Heft v. pp. 241–246.

Cauda corporis elongata filiformis.

This genus was established by H. and A. Adams, but remained almost entirely unknown until the publication of my Monograph. I then showed that the two genera *Acura* and *Phylliroë* could not be distinguished by any essential external characters, and exhibited no great differences in their internal structure. I was however unable, owing to the bad state of preservation of the specimens, to find a renal organ in *Acura*. My renewed examination of the animal has clearly shown the presence of this latter organ. The only character by which *Acura* can be differentiated from *Phylliroë* is by the presence inthe former of a *pointed, elongated, mostly filiform tail;* and even this in one species (*Acura lanceolata*, Bgh.) is rather short, and thus establishes a link between *Acura* and *Phylliroë*.

In its biological relations the genus *Acura* very probably entirely agrees with *Phylliroë*.

Only two species are known :—

1. *Acura lanceolata*, Bgh.
Philippine Sea, Pacific.

2. *Acura pelagica*, Ad.
Atlantic.

1. *Acura pelagica*, H. and A. Adams (Pl. X. fig. 4).

Acura pelagica, H and A. Adams, *loc. cit.*, p. 98, pl. lxx. fig. 4.
„ „ Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.) Heft v. pp. 242–246, Taf. xxx. figs. 6–19; Taf. xxxi. figs. 3, 4.

Five specimens of *Acura pelagica* were captured in the East Atlantic, off the coast of Africa, on August 16, 1873, and in the South Atlantic, on October 14, 1873. Some specimens were preserved in alcohol, others mounted on slides.

The length of the body (excluding the rhinophoria and the tail) is from 7 to 8 mm.; the tail is nearly as long as or even a trifle longer than the body; the *rhinophoria* were of the usual length. The *colour* was quite typical. The *form of the body* is rather more elongated than in *Phylliröe*, but not so high; in one individual the penis was everted, and appeared to be almost equal in length to the body.

The *central nervous system* entirely resembles that of *Phylliroë*, as do also the eyes and the otocysts; the latter organs are visible beneath the eyes as chalk-white points, they each contain from 150 to 200 otoconia.

The *bulbus pharyngeus* and the mandibles resemble those of *Phylliroë*. I examined the radula in two individuals, and found it to consist of fifteen to sixteen series of teeth. Further back there were only five fully-developed series, but two other imperfectly developed series were present. The total number of series thus amounted to twenty-two and twenty-three in the two specimens. The number of teeth in the series was 6–1–6; their form has been already described by me.

The *salivary glands*, with the rest of the digestive tract and its hepatic sacs, were quite as in *Phylliroë*. The *renal chamber* (fig. 4, *e.c*) long and somewhat irregularly contracted; the *renal syrinx* (fig. 4, *d*) resembles that of *Phylliroë*, and is about 0·2 mm. in length; the *ureter* (fig. 4, *f*) as in *Phylliroë*. Two *hermaphrodite glands* are present, and closely resemble in form and colour those of *Phylliroë atlantica*, as does also the *penis*. There is no spermatheca.

2. *Acura lanceolata*, Bergh.

Phylliroë lanceolata, Bergh, Malacolog. Untersuch., *loc. cit.*, p. 241, Taf. xxxi. fig. 5.

To this species is probably to be referred an *Acura* captured in the West Pacific, on the surface, March 27, 1875. The specimen was preserved on a slide. It measured nearly 13 mm. in length, and 3 mm. in height. The form of the body agrees closely with the figure given by Semper. As far as could be made out, a renal sac was present, and there appeared to be two hermaphrodite glands, as also mentioned by Semper; the hepatic cæca were quite as in the former species.[1]

Family Æolidiadæ.

Of this large Family only a few forms were captured during the expedition.

Fiona, Alder and Hancock.

Fiona, Alder and Hancock,—Forbes and Hanley, British Mollusca, vol. iii., 1853, p. x.
„ Alder and Hancock, Monog. Brit. Nudibr. Moll., part 7, 1855, p. 52, pl. xxxviii. *a*.
„ Bergh, Beitr. zur Kenntn. d. Æolidiaden I., Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, xxiii., 1873, pp. 605–610;—V., *loc. cit.*, xxvii., 1877, pp. 823, 824.
„ Bergh, On the Nudibr. Gastr. Moll. of the North Pacific Ocean (*in* Dall, Scientific Results of the Exploration of Alaska, vol. i., art. v.) part 1, 1879, pp. 85 (141)–88 (144).
Hymenæolis, A. Costa, Annuario del Museo zool. di Napoli, III., 1866, pp. 64–80,—IV., 1867, p. 28.

Corpus elongatum, gracile; rhinophoria et tentacula subsimilia, simplicia. Papillæ (dorsales) cuti firmius affixæ, elongatæ, ob membranam branchialem quasi alatæ; bursa cnidophora nulla. Anus dorsalis dextrorsum situs; aperturæ genitales discretæ, geminæ.

[1] Semper only found three cæca—the antero-inferior being absent. This must be merely an individual abnormality. In a specimen of *Phylliroë atlantica* which I examined, the antero-superior cæcum was reduced to a mere rudiment (Bergh, *loc. cit.*, Taf. xxix. fig. 7*f*.).

Mandibulæ cymbiolatæ, antrorsum sensim angustiores, processu masticatorio breviori subhamato, margine masticatorio singula serie denticulorum armato. Lingua elongata, compressa, serie dentium unica ; dentes arcuati, cruribus angustis, acie cuspide prominulo et utrinque denticulis compluribus. Penis inermis.

The genus *Fiona* differs from all the other Æolidiadæ in having a proper branchia attached to the inner side of the dorsal papillæ.

A few species have been described, all pelagic in habit, which do not markedly differ from each other, and may eventually prove to belong to one circumæquatorial cosmopolitan form.

1. *Fiona marina* (Forsk.).
   Atlantic, Mediterranean.
2. *Fiona pinnata* (Eschsch.).
   South Pacific.
3. *Fiona longicauda* (Quoy et Gaim.).
   Pacific (neighbourhood of New Zealand).
4. *Fiona* (?) *alba*, var. (van Hass.).
   Indian Ocean.

Fiona marina (Forskål), (Pl. XI. fig. 1).

Limax marina, Forsk., Descript. Animalium, p. 99 ; Icon. animal., t. xxvi., fig. *Gg*.
Fiona nobilis, Alder and Hanc., *loc. cit.*, p. 10.
„ *atlantica*, Bergh., Anat. Unters. af Fiona Atlantica, Vidensk. Meddel. f. d. nat. Foren. i Kjøbenh., 1857, pp. 273–337, Taf. ii.–iii.
Hymenœolis elegantissima, Costa, Ann. del Mus. zool. di Napoli, III., 1866, p. 64, 80 ; IV., 1867, p. 28.
Fiona marina (Forsk.), var., *pacifica*, Bergh, On the Nudibr. Gastr. Moll., &c., *loc. cit.*, pp. 86–88, pl. i. figs. 7, 8.
„ *pinnata* (Eschsch.), Bergh, Beitr. zur Kenntn d. Æolidiaden. I., *loc. cit.*, 1874, pp. 606–610, Taf. viii. figs. 2–11, Taf. ix. fig. 13.

Three specimens of this species were captured on the surface in the north-west Pacific, on June 29th, 1875, and were preserved in picric acid.

The three specimens, no doubt somewhat contracted, were about the same size ; the largest measured about 13 mm. in length, 4 mm. in breadth, and 4·5 mm. in height, the length of the tail was 4 mm.

The structure of the central nervous system was quite typical, but the otocysts could not be detected.

The *bulbus pharyngeus* in the two specimens which I examined measured 2·75 and 3 mm. in length. The *radula* contained 15 to 16 series of teeth and 6 to 9 loose teeth

were always seen lying at the root of the tongue, between it and the inferior wall of the buccal cavity (fig. 1). Further backwards there were twenty-one or twenty-two fully developed and two incompletely developed series; the total number of series of teeth was thus thirty-eight (forty-four) and forty (forty-nine) in the two individuals. Each of the teeth was provided with six or seven denticles on either side of the apex.

The oral glands (*glandulæ ptyalinæ*) were present and quite typical, but the true salivary glands (*glandulæ salivales*) were wanting.

It is probable this species is circumæquatoral, and that *Fiona pinnata* (Esch.) and *Fiona longicauda* (Quoy et Gaim.) will turn out to be identical with the common form of the Mediterranean and Atlantic. I have seen series of individuals from different parts of the Southern Ocean, as well as from the Japanese Sea, which in external characters and internal structure presented no differences from the typical form of the Atlantic.

Glaucus, Forster.

Glaucus, G. Forster, A Voyage round the World in the "Resolution," 1777, vol. i. p. 49.
Eucharis, Péron, Voy. de découvertes aux terres australes, 1807–1810, pl. xxix. fig. 2.
Dadone, Gistel, Naturgesch. des Thierreichs, 1848, p. 174.
Laniogerus, Blainville, Manuel de Malacol., 1825, p. 485.
Nausimacha, Gistel, *loc. cit.*, p. 174.
Glaucus, F., Bergh, Anat. Bidr. til Kundsk. om Æolidierne, K. dansk. Vidensk. Selsk. Skrif. R. 5, Naturv. og math. Afdel. viii., 1864, pp. 243–302, Taf. vi.–ix.
„ F., Bergh, Beitr. zur Kenntn. der Moll. des Sargassomeeres, Verhandl. d. k. k. zool.-bot. Gesellsch. Wien., xxi., 1871, pp. 1300–1301.
„ F., A. Vayssière, Observ. sur l'anat. du Glaucus, Ann. d. Sci. Nat., sér. 6, t. i., 1874, pp. 1–17, pl. viii., ix.

Rhinophoria et tentacula fere rudimentaria, simplicia. Truncus, præsertim antice, quasi applanatus, lateribus tanquam brachiis duobus dilatatus, in quibus papillæ linea curvata (vel lineis) impositæ; in parte posteriore trunci utrinque præterea series papillarum duæ obliquæ. Cauda elongata. Podarium sat angustum antice truncato-rotundatum.

Mandibulæ validæ, convexitate duplici, supera altiore et breviore, inferiore longiore; mandibulæ superne præterea lamina horizontali præditæ; processus masticatorius serie denticulorum armatus. Radula dentibus uniseriatis validis.

Glans penis hamo curvato forti armata, vel inermis.

These animals were first scientifically examined by one of the best naturalists of the earlier part of the eighteenth century, F. Ph. Breyn. He captured numerous specimens in the Mediterranean close to the Island of Iviça, and sent a communication to the Royal Society[1] concerning these animals and some Porpitæ which were obtained at the same time.

[1] De plantis et insectis quibusdam rarioribus, *Phil. Trans.*, vol. xxiv., 1705, p. 2054, pl. ii. fig. 4; *Ephem. Nat. Cur. Cent.*, vols. v. and vi., 1717, App. pp. 104, 105, Taf. xiv. fig. 4.

Half a century later[1] another communication was made to the Royal Society by the learned A. P. du Pont, on some specimens of the same animal which had been sent to him by a friend in Jamaica. Gmelin, ignorant of the earlier memoir of Breyn, established, on the strength of the latter memoir of Du Pont, a new species, which is described in his Systema Naturæ[2] under the name of *Doris radiata*. Previously, however, to the publication of Gmelin's work, the animal had been recognised as the type of a new genus by Forster. The two Forsters (J. Reinhold and George), who accompanied Captain Cook on his second voyage, observed the animal during the cruise to the Cape, and the elder Forster gave it the name *Glaucus* ("nomen ex deo marino et colore animalis")[3]. Forster seems to have kept up a correspondence with Blumenbach, and to have sent him an account of the new genus, which was published in his manual of natural history. Gmelin also had received, either from Forster himself or from Blumenbach, some account of *Glaucus*, but he does not seem to have perceived the identity of this form with the Mollusc which he had already described as *Doris radiata*.[4] A few years later (1795) Poli changed the name into *Glaucoderma*.[5] The elder Forster (J. R.) left among his papers a short treatise on the genus *Glaucus*, which was subsequently published by Blumenbach, with additional notes, in Voigt's Magazin,[6] and about the same time a figure of the animal by Blumenbach appeared in the 5th part of his Abbildungen Nat. Gegenst.[7] From these two last mentioned publications dates our knowledge of this animal. Cuvier[8] adopted the generic name of *Glaucus*, chiefly, however, on account of the description given of the animal by the French naturalist Péron.[9]

After Forster several French naturalists who accompanied various scientific expeditions published descriptions of this interesting form. La Martinière, who was the companion of La Peÿrouse, and shared his fate, sent some scientific communications with remarks on these animals to the editors of the Journal de Physique; an abstract of these is to be

[1] An account of a remarkable marine insect, *Phil. Trans.*, vol. liii., 1763, pp. 57, 58, pl. iii.

[2] Systema Naturæ, vi., 1780, p. 3105.

[3] G. Forster, *loc. cit.*, p. 49. "Monday, 14th Sept. 1772. We had also at various intervals found the sea covered with animals belonging to the class of Mollusca, one of which, of a blue colour, in shape like a snail, with four arms divided into many branches, was named *Glaucus atlanticus*."

[4] With his usual carelessness, Gmelin (*loc. cit.*, p. 3149) had not remarked that the "vermis marinus" of La Martinière was a form nearly identical with the species of Du Pont, and considered it to be a "*Clio*."

[5] The *Glaucus* of Klein (Hist. nat. pisc. missi., v., 1749, p. 3), seems to be the *Naucrates* of Rafinesque.

[6] Voigt, *Magazin*, v. 4, April 1803, p. 336, Taf. viii. This "Magazin für den neuesten Zustand der Naturkunde" (i.–xii., 1796–1806) is not to be confounded with the continuation of Lichtenberg's "Magazin für das Neueste aus der Physik und Naturgeschichte" (i.–xii., 1781–1797), which was also edited by Voigt. The article cited here is found reproduced in Lichtenberg's, Forsteri descript. animal., 1844, pp. 10–12.

[7] Blumenbach, Abbild.-Natur. Gegenst., i–x., 1796–1810, Taf. xlviii.

[8] *Ann. du Museum*, vi., 1805, p. 426, Règne anim., &c.

[9] Péron (Péron et Lesueur, Hist. de la fam. des moll. Ptérop., pp. 75, 80, pl. ii. fig. 9,—*Glaucus australis*, *Ann. du Mus.*, t. xvi, 1810) regarded *Glaucus* as belonging to the Pteropoda, although Cuvier had already, only by the help of Péron's drawings, assigned the animal to its proper place ("in the neighbourhood of the Scyllæ and Tritoniæ").

found in the number of the journal for November 1787[1]; a figure of *Glaucus* was published somewhat later in the "Voyage."[2] Another French zoologist, Bosc, observed a similar form in the Atlantic, but described it as a *Scyllæa*.[3] A more extended account of the animal was given by the two naturalists who accompanied the South Sea Expedition of Captain Baudin. Bory de St. Vincent left the expedition in 1802, and on his return published his Voyages aux quatres principales îles d'Afrique, which appeared in the year 1804; on pl. vi. fig. 1 A, B, of this work is a figure of a *Glaucus*, which seems to differ from Forster's species, and was regarded by Lesson as identical with that described by Bosc, to which the name *Glaucus boscii* had been given. Péron, the other companion of Baudin, also made some observations upon this animal, and had it figured by Lesueur. In his large work[4] he created for it the generic name *Eucharis*, but subsequently restored the original name of *Glaucus*.[5] The species which Péron described as new, under the name of *Glaucus eucharis*, Pér.,[6] forms a part of the collection *Glaucus hexapterygius* of Cuvier. Other travellers:—Eschscholtz, Rang, Lesson, d'Orbigny, Quoy and Gaimard, and Souleyet, had frequently the opportunity of seeing these animals, nevertheless their descriptions as well as figures are nearly always valueless. Some malacologists have considered that all these descriptions refer to one and the same species (Lamarck, Blainville,[7] Quoy et Gaimard, Souleyet), others consider that there are no less than six (Lesson, Gray).[8]

In 1864 the present author published a monograph of the genus, chiefly anatomical. Previously to this but little had been known about their structure. Cuvier[9] does not appear to have studied the anatomy of this form, since he places it near the Tritoniæ, and the notes of Blainville[10] are not of any real value. Quoy and Gaimard[11] made some observations on the anatomy of *Glaucus*, and gave a description and figures of the jaws, penis, and spawn. Lovèn subsequently described the radula.[12] The first important description of the structure of *Glaucus* was given by Souleyet,[13] who clearly demonstrated its affinities with the Æolidiadæ.

[1] *Journ. de Physique*, t. xxx. 2, 1787, p. 366, pl. ii. fig. 5.

[2] Voyage de la Peyrouse, t. iv. p. 71, pl. xx. figs. 15–16.

[3] Bosc, Hist. nat. des Vers, I. (an X.) p. 87, pl. iii. fig. 3.

[4] Voy. de découvertes aux terres australes, 1807, 1810, pl. xxix. fig. 2.

[5] Blainville, Dict. d. Sci. Nat., t. xix., 1821, p. 37.

[6] Perhaps this species is identical with *Glaucus australis* of the same author, and thus with *Glaucus peronii* of Lesson.

[7] Mostly from notes made by Lesueur (Dict. d. Sci. Nat., *loc. cit.*, p. 37).

[8] According to Gray (Guide to Moll. in Brit. Mus., part 1, 1857, p. 222) these species are *radiatus, atlanticus, draco, forsteri eucharis, pacificus*. The first two are identical, and form, together with *Glaucus forsteri*, the typical form *Glaucus atlanticus*. *Glaucus eucharis* of Lesson, from Mozambique Sea, is perhaps a separate species, as also the two species described by Eschscholtz from the Pacific, *Glaucus draco* and *pacificus*.

[9] Règne anim., Ed. II., 1830, iii. p. 54.

[10] Dict. d. Sci. Nat., xix., 1821, pp. 35–37.

[11] Voy. de l'Astrolabe, Zool. Moll., 1833, pl. xxi. figs. 6–14.

[12] *Öfversigt k. Vetensk.-Akad. Förhandl.*, 1847, p. 175 (189 !), Tab. 3, *Glaucus hexapterygius*.

[13] Voyage de la Bonite, Zool., t. ii., 1852, pp. 440–442, pl. xxiv.

The most conspicuous external character of this genus consists in the *armlike lateral prolongations* of the anterior part of the body, which are especially developed in *Glaucilla*. Of these arms there are two pairs, the anterior being much stronger than the posterior. Sometimes the rudiment of a third pair is visible in a small cushion-shaped prominence. On the outer part of these arms are situated the papillæ, generally in a single series, but sometimes (*Glaucilla*) in several series. In addition to these three groups of papillæ there is, at any rate in large specimens, a fourth series. This is probably to be found in all the species of *Glaucus*, though only three groups have been described by several authors. The papillæ are long and conical in shape, and become easily detached from the body. The body terminates in a long thin tail. The rhinophoria, which have a simple conical shape, are but slightly developed; the conical tentacles are small. The foot is rather narrow; the anterior extremity is truncated and rounded with very slightly prominent edges.[1] The genital aperture is situated behind the first arm, and the anus behind the second, slightly anterior is the opening of the renal organ.

The colour of these animals is remarkable. The under side of the body as well as of the papillæ is a fine ultramarine blue; the upper surface is greyish but with a more or less strongly marked silver tint, which is also visible on the under surface. According to the observations of Reinhardt, made during the "Galathea" Expedition, this silver colour disappears when the animals are removed from the influence of sunlight.[2]

In the form of its jaws *Glaucus* differs from all other Æolidiadæ; they show a double convexity, and at the upper part are continuous with a horizontal plate. The radula only contains a single series of teeth, which are of the usual form with a prominent point, and on either side a series of strong denticles.

Unlike what is found in most other Æolidiadæ (*pleuroproctæ*), the common bile duct (the prolongation of stomach) lies beneath instead of above the hermaphrodite gland, as also in the *Tethydæ*, *Dendronotidæ*, *Dotidæ*, and *Proctonotidæ*. The papillæ dorsales are always provided with an urticating apparatus. The *penis* is always very strong and curved, and in the proper Glauci, armed with a strong curved hook.

These animals inhabit the warmer parts of all the open seas, extending as far as 35° or 36° on either side of the equator, but rarely beyond.[3]

According to the observations of several naturalists (Chamisso, Eisenhardt, d'Orbigny,[4] Reinhardt[5]), their movements are but slow, hence the old name of "Lacertæ marinæ" would appear to be somewhat inappropriate. Bennett, however (Proc. Zool. Soc., iv., 1836,

[1] The foot, therefore, is rather well developed, and it is not easy to understand how Lesson (Voy. de la Coquille, Zool., t. ii. p. 286) could have written—"Le pied est nul à moins qu' on ne prenne pas pour rudiment de pied la ligne moyenne argentée qui suit toute la longueur du ventre."

[2] Bergh, K. Dansk. Vidensk. Selsk. Skrif. R. 5, Bd. vii., 1864, pp. 247-248. Bennett (*Proc. Zool. Soc.*, vol. iv., 1836, p. 117) mentions the rapidity with which these animals change their colours when dying.

[3] Bergh, *loc. cit.*, pp. 249, 254. [4] Voy. aux îles Canaries, p. 42. [5] Bergh, *loc. cit.*, p. 249.

p. 118), remarks on the great mobility of the tail, which may possibly have suggested a comparison with the tail of a Lizard to the older naturalists. They appear never to swim actively about, but merely to float on the surface of the sea with the foot uppermost, the papillæ serving as "balancers."[1] According to Bory de St. Vincent and Forster[2] this position is sometimes reversed, but Reinhardt did not observe this. These animals take in and expel air through the mouth (Forster, Bennett, Reinhardt), and Reinhardt[3] states that immediately after the expulsion of air-bubbles, a bluish fluid, not readily soluble in sea water, is evacuated. This fact is also noticed by Forster[4] and Bennett;[5] the latter, however, describes the fluid as brownish in colour, and regards it as being of a fœcal nature. In the specimens of *Glaucus* which I examined, there was nearly always a quantity of air in the stomach, which was readily expelled from the mouth, together with a violet-coloured liquid, on applying a slight pressure to the back of the animal. The contractility of the body and its appendages is very great, and accounts for the differences that exist in the figures given by various authors. The papillæ of the body are readily detached, as in many other Æolidiadæ. According to Forster,[6] this is also the case with the tail; I very rarely saw an individual, however, that was without a tail.

According to Vayssière, *Glaucus* is phosphorescent. Its food appears to consist chiefly of *Velella* and *Porpita*.[7] Quoy and Gaimard[8] were the first to give a description of the spawn of *Glaucus;* it has since been figured and described by Souleyet,[9] and by myself.[10] D'Orbigny[11] states that the spawn is deposited upon the disc of *Velella*. Copulation has been observed and described by d'Orbigny and Lesson,[12] and I have myself[13] noticed individuals which appeared to be in the act of copulation. The development is up to the present quite unknown.

When preserved in alcohol, these animals become very much altered in shape, and for this reason very different accounts have been given of the number of species which exist. Most observers who have seen the living animals, distinguish several species (Rang 2, Eschscholtz and Reinhardt 4, Lesson 6); those, on the other hand, who have

[1] The assertions of some naturalists that *Glaucus* is able to swim by means of the "gills" were denied by Chamisso and Eisenhardt (*Nov. Act. Nat. Cur.*, X., 1821, p. 347), as well as by Eschscholtz (Zool. Atl., Heft 4, 1831, *p.* 16). The statement of the last-mentioned author that the animal swims by means of air-bubbles under the "ventral disc" (*loc. cit.* and *Isis*, 1825, I. col. 737) means really that it is kept floating at the surface of the water by help of the swallowed air. A. Adams (*Ann. and Mag. Nat. Hist.*, ser. 2, vol. xix., 1857, p. 462) appears to have noticed this habit of swallowing air, and Forster many years ago (Voigt, *Magazin*, *loc. cit.*, p. 361) saw the expulsion of air-bubbles through the mouth ("per os spirant").

[2] Voy. de la Coquille, t. ii. p. 284. Voy. aux quatres îles d'Afrique, I., p. 136, pl. vi. fig. 1, A.B. Voigt, *Magazin*, &c., *loc. cit.*, p. 341.

[3] Bergh, *loc. cit.*, p. 250. [4] Voigt, *Magazin*, &c., Bd. v., 1803, p. 341. [5] *Loc. cit.*, p. 115.

[6] Voigt, *Magazin*, &c., p. 341. [7] Bennett, *loc. cit.*, pp. 113–119; Bergh, *loc. cit.*, p. 251. [8] *Loc. cit.*, p. 279.

[9] Voyage de la Bonite, p. 442, pl. xxiv. fig. 25.

[10] Bergh, *loc. cit.*, pp. 281, 291, 293, 298, 302, Taf. vii. fig. 18. In Gray's Figures of Molluscous Animals (vol. iii. pl. cci. fig. 6*a*) the spawn is not well represented (after a drawing of Hooker ?).

[11] Voy. aux îles Canaries, p. 42. [12] *Loc. cit.*, pp. 280, 287. [13] Bergh, *loc. cit.*, p. 282, Taf. vii. fig. 14.

only seen specimens preserved in spirit, consider that there is but one circumæquatorial species (Lamarck, Blainville). Reinhardt, who accompanied the expedition of the Danish ship "Galathea" (1845–48), paid special attention to these creatures, and made a good many notes upon them; these notes, together with some beautiful coloured drawings of the living animal, which were executed by the artist of the expedition, were kindly placed at my disposal. Reinhardt considers that there are several species of *Glaucus*, which perhaps may be identical with some of the species of earlier authors. It is impossible, however, to speak positively.

Glaucus may be divided into two sub-genera,—*Glaucus* and *Glaucilla*.

Sub-Genus 1. *Glaucus* (Forster).

Caput parvum; corpus gracilius, longicaudatum; brachia breviora, papillis uniseriatis. Penis hamo armatus.

1. *Glaucus atlanticus*, Forster.

   Mediterranean,[1] Atlantic.

2. *Glaucus gracilis*, Bgh.

   Glaucus gracilis, Bergh, *loc. cit.*, pp. 285–287.

   Atlantic.

3. *Glaucus lineatus*, Reinhdt., Bgh.

   (!) *Glaucus peronii*, Lesson, Voyage de la Coquille, Zool., t. ii. 1, 1826, p. 288.
   (!) „ *flagellum*, Blumenbach, Voigt, Magazin, Bd. v. 4, 1803, p. 336, Taf. viii.
   „ *lineatus*, Bergh, *loc. cit.*, pp. 287–291, Tab. viii. A.

   South Pacific.

4. *Glaucus longicirrus*, Rhdt., Bgh.

   North Pacific.

5. *Glaucus eucharis*, Lesson.

   Sea off Mozambique.

[1] Besides Breyn, who was the first to describe the animal (1705), Rang (Man. de l'hist nat. d. Moll., 1829, p. 126) is the only naturalist who mentions the occurrence of *Glaucus* "in large swarms" in the Mediterranean. Neither the later French nor the Italian malacologists appear to have noticed its presence in this sea.

Sub-Genus 2. *Glaucilla*, Bergh.

Glaucilla, Bergh, *loc. cit.*, p. 295.

Caput validum; corpus subventricosum, brevicaudatum; brachia magis prominentia, papillis pluriseriatis. Penis inermis.

1. *Glaucilla marginata* (Reinh.), Bgh.

Glaucilla marginata, Bergh, *loc. cit.*, pp. 296–300, Tab. ix. A.

North Pacific.

2. *Glaucilla briareus* (Reinh.), Bgh.

South Pacific.

Glaucus atlanticus,[1] Forster (Pl. XIV. fig. 16).

Hirudo marina, Breyn, Phil. Trans., No. 301, vol. xxiv., 1705, p. 2045, pl. ii. fig. 4.
„ „ Du Pont, Phil. Trans., vol. liii., 1763, p. 57, pl. iii.[2]
Glaucus atlanticus, Forster, Voyage round the World in the "Resolution," 1877, vol. i. p. 49.
Voigt, Magazin, Bd. v. p. 4, 1803, p. 336, Taf. viii.
„ „ Blumenbach, Abbild. naturg. Gegenst., Taf. xlviii.
„ „ Lichtenstein, Forsteri descr. anim., 1844, p. 11.
Doris radiata, Gmelin, Syst. Nat., vi., 1790, p. 3105.
Scyllæa margaritacea, Bosc, Hist. nat. des Vers, t. iii., 1802, p. 101, pl. iii. fig. 8.
„ „ B. Bory de St. Vincent, Voyage aux quatres principales îles de l'Afrique, pl. vi. fig. 1, a, c.
Glaucus hexapterygius, Cuvier.
„ *octopterygius*, Cuvier.
„ *boscii*, Lesson, Voyage de la Coquille, Zool., t. ii. 1, 1826, p. 288.
„ *forsteri*, Lamarck.
„ „ L., Quoy et Gaimard, Voyage de l'Astrolabe, Moll., p. 279, pl. xxi. figs. 6–14.
„ *radiatus*, d'Orb., Voy. aux îles Canaries, p. 42.
? *Laniogerus elfortii*, Blainville, Manuel de Malacol., 1825, p. 485, pl. xlvi. fig. 4.
blainvillei, Goldfuss, Handb. d. Zool., 1820, Bd. i. p. 655.
Glaucus atlanticus, F., Bergh, K. dansk. Vidensk. Selsk. Skrif. R. 5, Bd. vii. p. 253–285, Tab. vi., vii.

One specimen was taken in the Atlantic ("August to September 1875") lat. 2° 34′ N., long. 149° 9′ W., at the surface, and another on May 5, 1876. The first specimen was small, measuring only 5·5 mm. in length, 2·5 mm. in breadth, and 1·6 mm. in height.

[1] *Glaucus tetrapterygius*, which Rang (Man. de l'hist. nat. d. Moll., p. 126) described as having "two pairs of gills," is after all probably a doubtful species, as is also a form figured and described in the *Mag. Nat. Hist.*, vol. vi., 1833, p. 318 (extract of the voyage of Mathews to and in Brazil).

[2] In a large treatise (Titius, Gemeinnützige Abhandl. i., 1768, p. 271), Hanow, a professor in Dantzic, endeavoured to show that the animal described by Du Pont was the young of *Squalus squatina*!

The *relative proportions* of the parts of the body were quite typical. The colour has been already described.[1] The dorsal papillæ of the two first groups are arranged in arches, the first of which was the largest and appeared to be complete, containing from ten to eleven papillæ; one of these papillæ is very large, its length about equalling the diameter of the body of the animal; at the side of this another rather large papilla, and the papillæ following this decrease in size towards the ends of the arch. The second arch contains a smaller number of papillæ (6 to 8), of which one is much larger than the others. Behind this comes a short row of two small papillæ, but no trace of a fourth group could be detected.[2] The arrangement of the papillæ and their form has been already described by me.

The viscera are conspicuously apparent through the walls of the body.

The *nervous system* has been thoroughly investigated by myself[3] and by Vayssière and v. Jhering.[4] According to the last-mentioned author, the central nervous system closely resembles that of *Phylliroë*, the "cerebro-pleural (cerebro-visceral) ganglia" of my monograph being in reality equivalent to the cerebral ganglia only of other molluscs, and the ganglia described by me as "pedal" being really composed of the fused pleuro-pedal (viscero-pedal) ganglia. This view I do not believe to be correct. The upper ganglia show an indistinct division into two parts, and since the development of the foot of *Glaucus* is not inferior to that of many other Æolidiadæ, or indeed of many Nudibranchiata in general, there is every reason to suppose that it agrees with these latter in possessing isolated pedal ganglia. According to von Jhering and other authors, all the commissures originate from the lower ganglia. This statement is not correct; the visceral commissure, at any rate, can be traced up to the lower side of the upper ganglia.

The *otocysts* contain from 20 to 28 otoconia. The eyes typical.

The *bulbus pharyngeus* measures 1·5 mm. in length. The mandibles typical, the masticating edge (Pl. XIV. fig. 16) being provided with a single series of pointed denticles, the largest of which measure ·0125 mm. The *radula* has twelve teeth; farther back six developed and two undeveloped teeth. Each tooth has from seven to eight denticles. The digestive system, renal organ, and urticating bag, have been already fully described by me. The latter organ is filled with urticating cysts and free urticating elements of the usual form, among which are several larger ones of a peculiar character.[5]—The genital system I have described elsewhere; the penis is typical in shape, having at its extremity a dirty yellowish coloured hook, measuring about 0·18 mm. in length.

[1] Bergh, Bidr. til Kundsk. om Æolidierne, *loc. cit.*, 1864, p. 256.

[2] In small specimens (6 to 7 mm. in length) previously examined by me (*loc. cit.*, p. 259), there was invariably a small rudiment of a fourth group, sometimes represented merely by a single papilla. In very small specimens (2 to 3 mm. in length) there was no trace of a fourth or even of a third group (pp. 283–284).

[3] Bergh, *loc. cit.*

[4] H. v. Jhering, Vergl. Anat. d. Nervensyst. d. Moll., Leipzig, 1877, pp. 183–185.

[5] Bergh, *loc. cit.*, p. 276, Taf. vi. fig. 29 **.

This specimen, like almost all the other specimens of *Glaucus atlanticus* dissected by me, was infested by *Distoma glauci*,[1] a form closely allied to *Distoma appendiculatum* of G. Wagner.[2] The animal (Pl. X. figs. 5–17) varies in length from ·41 mm. to 1·27 mm. The suckers are very large, the posterior nearly double the size of the anterior, measuring in large individuals ·16 mm. by ·2 mm. The tail was nearly always more or less retracted, sometimes entirely concealed (fig. 5). In several individuals (perhaps of a different species ?) there was no tail, and the hinder part of the body was filled with yellowish egg-like bodies (fig. 10).

Glaucus longicirrus, Reinhdt., Bergh. ?

(?) *Glaucus pacificus*, Eschsch., Zool. Atl., Hft. 4, p. 16, pl. xix. fig. 4.
„ „ Lesson, Voyage de la Coquille, Zool., t. ii. p. 288.[3]
Glaucus longicirrus, Bergh, *loc. cit.*, pp. 291–295, Taf. viii. B.

A specimen of *Glaucus* captured in the Pacific at the surface, July 1875, perhaps belongs to this species.

The specimen was preserved on a slide in glycerine, and measured 12 mm. in length. The number of papillæ on the first arm was fifteen or sixteen, on the second eight or nine; in the third series there were from five to six, and there seemed to be a fourth group with one or two papillæ. The longest papilla measured 7 mm.

Glaucilla briareus (Reinhdt.).

(?) *Glaucus draco*, Eschsch., Zool. Atl., Heft 4, p. 16, Taf. xix. fig. 5.
„ „ E., Lesson, Voy. de. la Coquille, t. ii. p. 288.
(?) *Glaucus distichoichus*, d'Orb., Voy. dans l'Amér. mérid., 1844, p. 196, pl. xiv. figs. 1-3.
Glaucilla briareus, Bergh, *loc. cit.*, pp. 300–302, Taf. ix. B.

Three small specimens captured in March 1875, in the West Pacific, belong possibly to this species, but having been, like the last species, very badly preserved, it is impossible to speak with certainty.

The length of the body was from 1·5 to 3 mm. The number of papillæ appeared to be smaller than in the original specimens examined by me.

Janolus, n. gen.

Forma corporis cum crista interrhinophoriali et ano postico-mediano sicut in *Janis*, limbus podarii latus.

Mandibulæ colossææ, margine masticatorio non denticulato. Dentes mediani linguæ hamo rudimentario; laterales numerosi, angusti, hamo breviori curvato.

[1] Bergh, *loc. cit.*, pp. 282–283.
[2] G. Wagner, *Archiv f. Naturgesch.*, Jahrg. xxvi. Bd. i., 1860, pp. 165–194, Taf. viii., ix.
[3] Reinhardt regarded the last two forms as specifically distinct, merely on account of a difference in colour.

This new group is allied to the genus *Janus*, and resembles it in the outward form of the body, in the arrangement of the dorsal papillæ, in the condition of the head, with its tentacles and rhinophoria, in the median position of the anal papilla on the posterior dorsal surface, and in the presence of the peculiar comb-like organ between the rhinophoria.[1] It differs, however, by the presence of a broad foot-brim, which probably assists the animal in swimming. This genus, however, is mainly distinguished by the enormous development of the mandibles, which, unlike what is found in *Janus*, form the sides of the bulbus; the lower portion of the mandibles resembles that of *Janus*, but the masticatory edge differs in so far as it is not provided with denticles as in the typical *Janus*. The radula is like that of *Janus*; the median series of teeth weak, with rudimentary hook; the lateral teeth numerous, with short recurved hook. In its internal structure the genus *Janolus* agrees on the whole pretty closely with *Janus*.

The two genera belong to a special group, which includes also the Proctonotidæ and the Madrellæ.[2] *Janolus* differs from the Proctonotidæ by the comb-like organ between the rhinophoria, and from the Madrellæ, moreover, by the dorsal position of the anus, by the presence of special tentacles, and by the numerous lateral teeth on the *radula*.

Only one species of this genus is known at present.

Janolus australis, n. sp. (Pl. VIII. figs. 15–22, Pl. IX. figs. 6–8).

Habitat.—Pacific (Arafura Sea).

A single example of this species was taken in the Arafura Sea, during September 1874. The specimen was treated with picro-sulphuric acid, and preserved in alcohol. The dorsal papillæ were nearly all wanting, but in other respects the animal was in good preservation.

The length was 3·2 cm., the height 1 cm., and the breadth of the dorsal surface 11 mm., of the foot 17 mm.; the breadth of that portion of the back which is beset with papillæ at most 3 mm. The height of the rhinophoria quite 6 mm.; the length of the tentacles 4 mm.; the height of the anal papilla 1·8 mm.; the length of the tail 5 mm.

The *colour* yellowish, but brownish or reddish along the middle line of the back; the region between the rhinophoria and the inter-rhinophorial "comb" is covered with a black spot, and the extremities of the rhinophoria are also blackish. The *form* of the body is somewhat short and depressed; the head flattened anteriorly, the mouth-opening perpendicular; the head is on every side produced into a rather narrow process, somewhat flattened below, which unites with the anterior edge of the foot and forms the upper lip of this anterior edge of the foot.[3] This wing-like process measures about 8 mm. in length, and is provided on its edge with a fine groove. The conical or finger-shaped *tentacles* take

[1] *Cf.* Bergh, Beitr. zur Kenntn. d. Æolidiaden I., *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien.*, Bd. xxiii., 1873, pp. 597–605, Taf. vii. figs. 1–6, Taf. viii. fig. 1.

[2] Alder and Hancock, Notice of a collect. of Nudibr. Moll. made in India, *Trans. Zool. Soc.*, vol. v. part 3, 1864, p. 141, pl. xxxiii. figs. 10–12.

[3] *Cf.* Bergh, *loc. cit.*, 1873, Taf. vii. fig. 1.

their origin from the lateral portions of the head; the *rhinophoria*, which are strong and conical, arise from the neck behind the anterior edge of the papilla-bearing dorsal wall; the stem is low, the club furnished (on either side) with about forty broad leaves (or laminæ). Between the rhinophoria is the slender somewhat depressed comb-like organ, which has a length of 2·5 mm. and a height of 0·8 mm., and which is divided into thick leaves by perpendicular furrows upon its edge which seem to be again divided. The eyes do not appear at the base of the rhinophoria. The *back* is somewhat broad, rounded at its anterior extremity, posteriorly it narrows, and ends in a sharp point. Its broad marginal portion, rather prominent at the edge, is covered with a dense mass of papillæ. In front this portion is somewhat narrower, and in the middle line that of either side is separated from the other by a narrow bare median space; at the posterior end the same conditions are repeated, but the median space is here narrower still. The papillæ appear to be arranged in a similar irregular fashion, as in the typical *Janus*. Only a few of the smaller papillæ were left, they appear to agree with those of the typical *Janus*. The anal papilla is situated on the dorsal median line, some way back (6 mm. from the end of the back); it is cylindrical in shape and truncated, with the folds of the intestine prolonged to the margin; it is directed backwards. The *sides* of the body are rather high at the middle, but diminished in height anteriorly and posteriorly. Rather backwards, corresponding with the anterior part of the pericardium, is the genital opening, surrounded by a horse-shoe shaped fold, and filled with the conically protruded end of the duct of the mucous gland, about 3·5 mm. high. Further back still, corresponding to the posterior end of the pericardium, is the conspicuous renal aperture. The *foot* is very large; in front it is straight, with a slight median notch, and with indications of a fine marginal furrow; as far as its slightly prominent corner, it is fused with the wings of the head already-mentioned. The foot stands out from the sides of the body, provided as it is with an undulating lateral brim about 3·5 mm. broad, which probably serves as an organ for swimming. The tail is broad and rounded at its posterior extremity; it has no sign of any keel.

The *pericardium* is the only part of the viscera that is visible through the walls of the body. The position of the viscera as in *Janus*.

The *central nervous system* (Pl. IX. fig. 6) is rather flattened and somewhat irregular; the cerebro-pleural ganglia (fig. 6, *ab.*) are rather elongated; an optic ganglion is present; the pedal and gastro-œsophageal ganglia resemble those of *Janus cristatus*. The eyes (fig. 6, *d,d.*) also resemble those of *Janus;* the outer end of the optic nerve is pigmented. At the base of the rhinophorion is the oval olfactory ganglion, which is somewhat larger than the buccal, and gives off a very stout and a thinner nerve. At the anterior margin of the club of the rhinophorion there are short leaves between the larger; the structure of the rhinophorion was quite typical.

The *mouth-tube* is about 1·3 mm. in length. The *bulbus pharyngeus* (Pl. VIII. fig. 15)

is enormously large, and measures 8·5 mm. in length, 10 mm. in height, and about 8 mm. in breadth. Its form is rather higher and shaped something like a helmet; the under surface is flat; the oblique anterior extremity of the body is narrow; the posterior extremity of the body, which is also oblique, is narrow above but considerably broader below; the sides of the body are divided into two halves, the anterior somewhat convex and the posterior concave, by a keel descending downwards and backwards. On the anterior margin, not far from the hinge (fig. 15, *b*) is the pharynx (fig. 15, *c*); the sheath of the radula is not at all conspicuous on the posterior surface. The structure of the *bulbus* is quite as usual. At the opening of the labial disk were visible the margins of the dark brown-coloured mandibles, closely approximated to each other.—The *mandibles* are far larger than those of any other Nudibranch. They are united to each other by a short, strong, tough, transverse band (above and below the small hinge). Each mandible was about 8·5 mm. long and 8·5 mm. in height; the thickness about the middle of its length was as much as 2·75 mm.; its colour a dull chitinous yellow, which changed on the lower part to a mahogany-brown, and on the antero-superior margin to a pale yellowish-white. The *outer* surface of the mandibles is convex, the inner a little concave; they meet anteriorly and posteriorly in a sharp edge; the inferior surface is very complicated. The outer surface (fig. 16) consists of two large facets, which slope anteriorly and posteriorly and meet in an oblique line or keel, which is directed downwards and backwards; this line becomes fused with the outer margin of the under surface; the hinder facette is in the upper part a little concave, or else very slightly convex. The somewhat convex antero-superior marginal part is separated from the anterior facette and from the upper edge of the mandible by a furrow, and as already mentioned is of a yellowish-white colour; the facette itself is somewhat arched; from its under surface (figs. 16, *a*, 17, *a*) is given off a powerful ridge (lying on the outer side of the hinge and serving for the attachment of muscles and the ligament); the ridge of the right mandible is stronger than that of the left. The *inner* surface is concave from above downwards (fig. 17), somewhat arched from before backwards; the upper marginal portion already mentioned is quite plain on this side; the inner lamella of the under surface is fastened to the antero-inferior portion of this side. The excavated *lower* surface (fig. 18) is continued obliquely forwards and inwards into a short stout process (processus connectivus), which is of the same dark colour as the rest of the under surface, and is cut short at the extremity. The strong outer lip of this surface is depressed, posteriorly it diminishes in height and runs in a straight course; the convex inner and outer surfaces of the lip are continued into the smooth, rounded, masticatory edge. The inner lip is stronger, shorter, more prominent downwards and shield-shaped (fig. 17, *b*) when seen from the inner side of the mandible, but somewhat flattened in the middle; the lower margin thin, smooth. From the anterior part of the inner lip a convex partition wall (fig. 18) extends downwards obliquely to the anterior part of the

outer lip. In front of this septum, and between both the lips, there exists a triangular groove deep in front (fig. 16); above the septum also there is a deep, nearly funnel-shaped cavity, the upper wall of which is formed from the anterior end of the under side of the substance of the mandible; the inner margin is here much more prominent (fig. 16). Transverse sections of the jaws show the colour of the main portion to be a pale, clear, chitinous yellow, only a thin layer on the under side and adjoining part was of a chestnut brown.—The large mass of muscles (fig. 19 *d*) (5·5 mm. broad posteriorly), which lies between the hinder margin of the jaws, is made up of thick horizontal transverse fascicles, quite distinct from each other; the function of these muscles is to divaricate the mandibles. The narrow *mouth-cavity* lies between the huge mandibles; it increases slightly in width in its course backwards and downwards, where it is entirely filled up by the tongue (fig. 19 *a*). The *tongue* is strongly compressed; it is short and keel-shaped, and has a length of 2·25 mm., and a height of 2 mm.; the anterior and upper margin is traversed by a deep groove; the muscular mass belonging to this tongue is also compressed, and is 3·5 mm. in length by 3 mm. in height, and 2 mm. in thickness at the cleft hinder end, lying in front of the mandibular muscles. The broad *radula* extends beyond the end of the tongue; there are sixteen series of pale yellow-coloured teeth; beneath the strong *tectum radulæ* (fig. 19 *b*), and within the radula sheath, which is dilated into an ampulla (fig. 19 *c*) posteriorly, are six developed and two not fully developed series; the total number therefore is twenty-four. In the eleventh series there are thirty lateral teeth on either side of the median tooth; within the foremost part of the sheath there are fifty-four, but the number does not appear to increase farther back. The plates were of a yellowish colour. The length of the lateral teeth of the radula reaches ·28 mm., with a height of ·05 mm.; the length of the next outermost tooth is ·12 mm., while the outermost one measures only ·1 mm. in length, the first being ·03, and the second ·025 mm. in height. The length of the coloured portion of the median tooth is from ·08 to ·1 mm., by a breadth of ·02 and a height about the same. The median teeth (Pl. VIII. fig. 20 *a*, Pl. IX. 7 *a*) are narrow, and only coloured in about their posterior third; farther forwards they are rather higher; the apex of the low, slightly bent hook reaches beyond the base (fig. 20 *a*). The lateral teeth also are narrow and slender (figs. 20 *b*, 7, 8), and somewhat bent; the basal portion is cut short in front, but rounded behind; the hook short but well developed; the yellow-coloured part of the teeth is continued anteriorly into a colourless cuticula (fig. 20 *c*, 7, 8). The innermost lateral tooth is the longest (figs. 20 *b*, 7 *c*). The length of the teeth diminishes gradually as we pass outwards, and somewhat more quickly in the outmost part (fig. 22, 8 *a*). Occasionally irregularities may be observed in the form of the teeth (fig. 21).

The *salivary glands* are slightly separated from each other; they are attached to the anterior margin and under surface of the stomach; the colour is brownish-grey. The œsophagus (Pl. VIII. fig. 15 *c*) is short. The *stomach* closely resembles that of the

genus *Janus*, and lies transversely; its length is about 7 mm., and its breadth 3·5 mm; on either side it receives the long yellowish-brown-coloured bile duct; near the left bile duct open the wider main bile-duct, which runs medially along the under surface of the hermaphrodite gland; the hinder pyloric end of the stomach has a thicker darker brown-coloured wall. The *intestine* resembles that of *Janus*.[1] The posterior bile duct as well as the intestine, when opened, was found to contain a mass of soft yellowish calcareous and animal débris, the nature of which could not be recognised. The *liver* is probably like that of *Janus*, but I am unable to say anything with certainty about the liver-cæca in the papillæ.

The heart and the renal system appear not to differ from those of *Janus*.

The *hermaphrodite gland* is of a beautiful reddish-yellow-ochre colour, and is of a short conical shape, with a slanting broad base and a slightly flattened rounded posterior end, its length is 11 mm., and its breadth 10 mm. The gland is made up of a small anterior right-hand, and a larger posterior left-hand portion; both these portions are composed of a great number of rounded, facetted, and finely granular lobules, measuring 2·25 mm. in diameter. The gland is acinous in structure; in the ovarian follicles are the large oogene cells. The *hermaphrodite duct* lies deep down between the two halves of which the gland is composed, and is formed from two main branches; the colour is whitish; in front of the hermaphrodite gland it forms a delicate coiled *ampulla*, 2 cm. long and ·5 mm. broad, which about the middle of the upper side of the *anterior genital mass* opens into it. This latter organ is about 11 mm. long, 7·5 mm. broad, 7 mm. high; the under surface is convex, the margins of the sides quite parallel; the upper surface, on account of the presence of the penis and the coiled knot formed by the vas deferens, decreases in size from the middle towards the anterior and posterior margins respectively. The *vas deferens* is yellowish in colour and coiled into a large roll; when uncoiled, its length is about 6 cm. and its diameter through its whole length ·3 mm.; it passes into the much thicker *penis*. This last, or to speak accurately the præputium, is 5 mm. long and 4 mm. in diameter, and is entirely occupied by the glans. The glans consists of a cylindrical portion and a broad horizontal piece forming its anterior third. I was able to trace out the vas deferens to its circular opening on one of the corners of the transverse piece of the glans; its diameter is uniform throughout its whole course. There is no armature either on the glans or in the vas deferens. The short sac-like seminal bladder has a length of 2·25 mm., it was filled with semen; its duct is about as long as the organ itself. The *albuminiparous gland* is yellowish, the slime-gland whitish; the duct has the usual fold.

Cuthonella, n. gen.

Corpus elongatum vix depressum. Caput sat latum, tentaculis vix longis, rhinophoriis simplicibus. Anus latero-dorsalis. Papillæ conicæ, vix caducæ, seriebus transversalibus, coetibus paucis aggregatis positis. Podarium sat latum, antice angulatum.

[1] The state of preservation of this part of the body permitted no sufficient investigation into the alimentary tract.

Mandibulæ sat breves, margo masticatorius seriebus denticulorum compluribus armatus. Dentes linguales uniseriati, cuspide prominenti, utrinque denticulati.—Penis inermis.

This novel form, for which I have established the generic name *Cuthonella*, somewhat resembles *Cratena*[1] and *Cuthona*,[2] but differs in some comparatively essential points. The anus, instead of being situated upon the side of the body, is dorsal and slightly lateral. The dorsal papillæ are not inflated; they are set in transverse or oblique rows, which are crowded together so as to form a few larger groups. In the specimen that I examined the cnidophorous bags were absent. The foot is not very broad, its anterior margin is truncated.—The mandibles are somewhat short, the masticatory edge provided with several series of strong denticles. The radula has a single series of largish teeth, with a denticulate cutting edge. The penis is unarmed.

The genus hitherto contains only one species.

Cuthonella abyssicola, n. sp. (Pl. X. figs. 1–3; Pl. XI. fig. 2; Pl. XII. figs. 9–13).

Habitat.—North Atlantic.

One specimen was taken by Mr. John Murray with the trawl, on August 23, 1882, in the Faröe Channel, lat. 60° 5′ N., long. 6° 21′ W.; in the cold area, from a depth of 608 fathoms; bottom temperature 30° Fahr.

The specimen had been preserved in alcohol and was somewhat contracted; the total length was 2·5 cm., the breadth 6 mm., and the height 6 mm.; the length of the tentacles 2·5 mm., of the rhinophoria 5 mm., and of the dorsal papillæ as much as 7 mm.; the breadth of the anterior portion of the foot 8 mm., the length of the tail 2·5 mm. The colour of the animal is of a uniform dirty-yellow, with the exception of the papillæ, which are of a light brownish-grey but yellowish at the tip. The intestines are not visible through the walls of the body.

The body is stout and elongated. The head rather flat, the tentacles short; the longer rhinophoria wrinkled; the mouth-aperture is vertically elongated, and forms a perpendicular slit. The foot is large, with a truncated anterior portion; the free edge of the foot projects about 1·75 to 2 mm. beyond the sides of the body; on the anterior margin of the foot is a furrow; the tail is rather short. The genital papilla is situated on the right side below the anterior half of the first group of papillæ, and consists of a prominence with the projecting glans (Pl. XII. fig. 10), behind which are two apertures placed upon a slightly excavated area (fig. 10). The median portion of the dorsal surface, which is free from papillæ, is in the anterior half about as wide as the lateral papilla-bearing portions. The

[1] R. Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft i., 1876, pp. 9–12, Tab. iv. figs. 1–15.

[2] R. Bergh, Beitr. zur Kenntn. d. Moll. des Sargassomeeres, *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien*, Bd. xxi., 1871, pp. 1280–1283.

papillæ are arranged in four groups on either side, but the arrangement is not so distinct as in other Nudibranchs. The first two groups are the largest and about equal in size; the two others smaller but corresponding with each other in size. Each group is made up of a number of short transverse or oblique rows, occasionally horse-shoe-shaped (Pl. XII. fig. 9, *c*); there are two to four, or sometimes as many as five or six, papillæ in each row. Altogether the first group contained about thirty papillæ, the second thirty to thirty-five, the third twenty-one to twenty-five, the fourth eighteen to twenty. The papillæ are conical in form, somewhat constricted at the base, and firmly attached to the skin; those on the outer side were nearly always much smaller than those on the inner side. The anal papilla is rather prominent (Pl. XII. fig. 9, *a*), and is situated on the right side of the body, on a level with the anterior end of the second group of papillæ. In front of it is the small triangular renal pore (fig. 9, *b*).

The central nervous system consists of a pair of somewhat flattened oval cerebro-pleural ganglia; the pedal ganglia are of about the same size as the cerebro-pleural; the subcerebro-pedal commissure is about equal in length to the longest diameter of one of the pedal ganglia; the visceral commissure is of about the same length. The olfactory ganglia at the root of the rhinophoria are rounded in shape; the oval buccal ganglia are of about equal size with the olfactory, the commissure uniting the two buccal ganglia is about as large as the ganglion itself; the gastro-œsophageal ganglia are provided with a short stalk, they are round in shape and contain one very large and several smaller cells, their size being about one-third of the buccal. The *eye* has a short stalk, the lens is yellowish, and the pigment deep black. The *otocyst* is a trifle larger than the eye, and has a very short stalk; it contains a number of rounded and not very strongly calcified otoconia.

The *bulbus pharyngeus* is strong and resembles that of the Æolidiadæ proper; it is about 4 mm. in length, 3·5 mm. in breadth, and 3·2 mm. in height; the sheath of the radula projects backwards, the labial disk is typical. The *mandibles* are strong and convex, of a chitinous-yellow colour; the hinge part is small, the simple *crista connectiva* narrow; the masticatory process (Pl. X. fig. 1) is short; its edge is provided with several series of somewhat compressed rounded teeth ·03 mm. in height (Pl. XI. fig. 2). The accessory buccal cavities are rather large (Pl. X. fig. 1, *c*). The *tongue* is strong and somewhat compressed, and has thirteen series of teeth; further back within the radula sheath are six developed and two undeveloped series, the total number being thus twenty-one. The colour of the teeth is chestnut yellow, the height of the anterior ones is ·1 mm., and passing backwards increases to about ·14 mm.; the breadth of the youngest teeth is about ·3 mm.; the form of the teeth (Pl. XII. figs. 11–13) is somewhat clumsy; on each side of the pointed apex are from ten to twelve denticles, which are often hook-shaped. The *salivary glands* are rather small and elongated, whitish in colour; the efferent ducts rather long.

The *œsophagus* is short and rather narrow, its length is 5·5 mm. The *stomach*

receives posteriorly the strong bile duct of the first group of papillæ; along its upper wall a strong fold runs from the cardiac to the pyloric end. The large main bile duct, which receives three or four smaller ducts on each side, runs through the hermaphrodite gland, in a groove on its lower surface; the duct, receiving 3–4 lateral bile ducts, enters the stomach close to its junction with the intestine. The course of the latter is downwards and then upwards to the anal papilla, the total length 6 mm.; its inner surface has numerous fine longitudinal folds, which decrease in number, but become stouter as the intestine passes backwards. The alimentary tract throughout its whole extent contained a quantity of animal matter, the nature of which I was not able to determine; it was full of variously sized cnidæ. The hepatic lobes are conical in form, but not quite equal in size; the upper surface occasionally showed granulations. No trace of any cnidophorous sacs[1] could be detected, but a pore was sometimes visible upon the summit of the larger papillæ.—The *pericardium* was quite typical; the ventricle of the heart about 1·75 mm. long. The *renal syrinx* pyriform in shape, 1·3 mm. long; the ureter about the same length as the latter; I succeeded in tracing it as far as the renal pore.

The hermaphrodite gland is long, the lobes large and irregular, composed of a number of smaller lobules; the rounded testicular parts are covered nearly all over with the white or yellow ovarian follicles; the gonoblasts are developed.—The anterior genital mass is about 6 mm. long by 4 in breadth, and 4·5 mm. in height. The ampulla of the hermaphrodite duct is elongated and sac-shaped, and curved in the middle; when straightened out it measures 4 mm. in length by about 1 mm. in diameter, and is of the usual opaque yellowish-grey colour. The *ductus ejaculatorius* (Pl. X. fig. 2, *aa*) is strong and coiled; when uncoiled it measures about 8 mm. long; it is somewhat thinner in the anterior third. The penis is much thicker, the præputium (fig. 2 *cc*) has rather thick walls. The glans is conical, about 2 mm. long, its anterior half freely projecting (Pl. X. fig. 2, *de*; Pl. XII. fig. 10). Into the ductus ejaculatorius opens another (Pl. X. fig. 2, *b*) somewhat thinner duct, which probably arises from some gland. The glans and the termination of the seminal duct are quite unarmed. The spermatheca (Pl. X. fig. 3, *a*) is oval in form; it was quite empty in the specimen which I examined; the duct is nearly twice as long as the organ (fig. 3, *bc*). The mucous gland is whitish, its cavity rather large; the albuminiparous gland rather more yellowish.

Between the *bulbus pharyngeus* and the anterior genital mass was found the female of an animal in form very like *Splanchnotrophus*;[2] another was imbedded in the superior face of the hermaphrodite gland; both individuals were about 5 to 6 mm. in length. No males were detected.[3]

[1] In the doubtful species *Cratena lugubris* (Bergh, Malacolog. Untersuch., *loc. cit.*, Heft i., 1876, pp. 9–12, Taf. iv. figs. 1–15) no cnidophorous sacs were found.

[2] The animals were too much hardened to allow of any thorough examination; it was impossible to examine properly the anterior genital mass.

[3] In *Homoiodoris japonica* I found both male and female individuals resembling *Splanchnotrophus*. *Cf.* Bergh, Beitr. z. Kenntn. d. japan. Nudibr. II., *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien.*, Bd. xxxi., 1881, p. 226, Note.

Rizzolia, Trinchese.

Rizzolia, S. Trinchese, Rendic. dell' Accad. di Bologna, 1879–80, p. 62.
„ R. Bergh, Beitr. z. Kenntn. d. japan. Nudibr. I., Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxx., 1880, pp. 156–160.
„ R. Bergh, Beitr. z. Kenntn. d. Æolidiaden, VII., *loc. cit.*, Bd. xxxii. 1882, pp. 37, 38.

Corpus gracilius elongatum; rhinophoria simplicia; tentacula elongata; papillæ (dorsales) non caducæ pedamentis humilibus impositæ; podarium antice angulis tentaculatim productis.

Margo masticatorius mandibularum serie denticulorum grossiorum. Radula paucidentata; dentibus uniseriatis, cuspidatis, denticulatis.

Penis inermis.

The genus *Rizzolia* was established by Trinchese in 1877. In external characters it closely resembles *Facelina*, but is readily distinguished by the rhinophoria, which are plain (not perfoliated), and by the unarmed condition of the penis.

Only the following species of the genus are known:—

1. *Rizzolia peregrina* (Gmelin).
Mediterranean.

2. *Rizzolia modesta*, Bergh.
Japanese Sea.

3. *Rizzolia australis*, n. sp.
Pacific Ocean.

Rizzolia australis, n. sp. (Pl. IX. figs. 1–5).

Habitat.—Pacific (Port Jackson).

A single specimen was dredged, together with *Chromodoris runcinata*, from a depth of 2 to 10 fathoms, in Port Jackson, on the 17th April 1874. It was strongly hardened through having been preserved in alcohol, and had lost its dorsal papillæ.

The specimen measured 18 mm. long, by a breadth and height of about 4 mm.; the height of the tentacles was 3·5 mm., of the rhinophoria 3 mm., and the length of the edges of the foot 1·7 mm.; the breadth of the sole of the foot was for the most part 2 mm.; anteriorly it was somewhat larger, posteriorly somewhat narrower; the length of the tail quite 4 mm. The *colour* throughout was of a yellowish-white, the anterior margin of the head was whitish, and from it a slender, whiter median line, discontinuous here and there, extended along the back; in front of and behind the rhinophoria there was a small transverse

band; on the posterior half of the back, below on the side of the body, and on the edge of the foot, there were a number of small partly white rounded oval spots, regularly arranged; the margin of the foot is whitish; the hepatic cæca are visible through the walls of the papillæ, and are brown or black.

The shape of the body is slender, like that of other specimens of the genus. The mouth-tube was invaginated; the strongly developed *tentacles* are sharply marked off from the rest of the head; the *rhinophoria* are cylindrical in shape and provided with about fifteen rings, and here and there half rings lying between the others. The naked part of the *back* is about double the breadth of the portions covered with papillæ; the breadth of the back decreases towards the hinder end, but the relation between the portions of the back covered with papillæ and the uncovered portion remains the same. On the lateral portions of the back the papillæ are arranged in six low horse-shoe-shaped cushions, and further back there are three isolated rows. The size of the cushions themselves, and of the intervals between them, decreases from before backwards. The anterior leg of the first 4–5 horse-shoes is stronger. The *first* horse-shoe-shaped group of papillæ has the anterior portion much thicker, and provided with about eight series of papillæ; the hindermost has only two rows. The *second* group is smaller, but the anterior portion of it is in the same way thicker, and has five or six rows of papillæ, the posterior portion only having two. At the upper end of the corner of this horse-shoe is the somewhat conspicuous anal papilla inclining towards the posterior leg. The renal aperture is more anterior, and a little lower down. The third, fourth, and fifth "horse-shoes" have each three to two rows of papillæ; on the hindermost there are sometimes only two rows or one. Most of the papillæ had fallen off, and only some of the smaller ones were preserved; they were club-shaped, with a pointed upper end. The *sides of the body* are high in front, decreasing gradually behind. The double *genital papilla* is situated near the anterior end of the first (right hand) group of papillæ. The *foot* is strong, broader in front, with a marginal furrow; posteriorly it gradually decreases in size; its free lateral margin is rather small; the tail is provided with a strong dorsal keel.

The intestines are visible through the body wall, especially on the back, less so at the sides of the body.

The cerebro-pleural *ganglia*[1] are somewhat quadrangular in shape and flattened, united with each other by a short commissure behind the middle of the ganglion; the line of division between the two component ganglia (cerebral and pleural) is very evident, the cerebral being a little the larger. The pedal ganglia are rather larger than the cerebral, somewhat compressed from before backwards, extending out from the infero-anterior portion of the underside of the former ganglia. The strong commissure is as long as the diameter of both cerebro-pleural ganglia; not far from either end the commissure

[1] This agrees with the nomenclature used by Spengel in his excellent memoir, Ueber die Geruchsorgane und Nervensystem der Mollusken, *Zeitschr. f. wiss. Zool.*, Bd. xxxv., 1881, p. 234.

gives off a strong branch; the special commissures making up the united commissural band could not be separated from each other. The spherical olfactory ganglion is situated in or at the root of the rhinophore, and is somewhat smaller than the buccal ganglion. The buccal ganglia are of oval contour, united by a commissure, which is about equal to half the ganglion in diameter; the gastro-œsophageal ganglion has a short stalk, its size is not more than one-sixth of that of the buccal ganglion.

The *eyes* are situated on the shallow excavation of the outer edge of the cerebro-pleural ganglia; the optic nerve is about as long as the diameter of the eye; the pigment is black, the lens yellowish. The *otolithic vesicles* are situated just behind the eyes, and are a little smaller than them in size; they contain some sixty otoconia of the normal form.

The *bulbus pharyngeus* (which was half projecting) is of the typical form, 5 mm. long, 3·5 mm. broad, and 2·5 mm. high; the radula-sheath projects slightly at the hinder end below; the labial disk is roundish, the boundary of the spacious accessory-buccal cavities is clearly visible through the walls of the bulbus. The *mandibles* are of a clear yellow colour, strongly arched; the anterior part of the upper margin is bent inwards, and forms a small horizontal surface, which is bounded by a keel, which, higher in front, extends as far as the crista connectiva; the hinge is small; the crista connectiva has a longitudinal furrow, which is not identical on both the jaws; the bent masticatory process is short and somewhat strong; the upper portion is quite smooth (worn out?); the rest was provided with about forty denticles, reaching, on the outer side, a height of ·06 mm. The denticles (Pl. IX. fig. 1) are divided by an oblique slit at the top, the inner part is conical, more or less bent, the outer part rather wing-shaped. The *tongue* has a clear yellow radula, with six plates on the under margin and four on the shorter upper margin, further backwards there were thirteen developed and two undeveloped teeth; the total number is therefore twenty-five. The teeth are chitinous yellow in colour, the breadth of the youngest (hindmost) ·26 mm., the height ·28 mm.; these teeth (figs. 2–5) show a rather long slender hook and four, occasionally three (fig. 3), strong denticles of the cutting edge of which the one beneath is generally the smallest.

The white *salivary glands* are 1·5 mm. long and ribband-shaped, posteriorly they are a little broader and lobate on the margin; the salivary ducts are not very short.

The *œsophagus* is short; the *stomach* rather large with a short oval contour; from either side two bile ducts arise from the two anterior groups of papillæ, at the hinder end is the main bile duct; the latter opens close to the pylorus; the inner surface is furnished with strong folds, which radiate out from the cardiac end. The main bile-duct is somewhat wider than the gut, running along the middle of the length of the dorsal surface of the hermaphrodite gland, receiving a bile-duct from each group of papillæ commencing with the third, and reaching behind the hermaphrodite gland. The gut is wide, its course

posteriorly is first downwards then upwards; it is covered at the middle by a large lobe of the hermaphrodite gland; when stretched, the gut measured 11 mm. in length and ·75 mm. in diameter. The inner surface has longitudinal folds, one of which is especially developed. The cavity of the gut contained a quantity of unrecognisable animal matter.

The lobes of the *liver*, within the papillæ, are tuberous; the almost spherical cnidophorous sacs are united to them by a short ligament; they were full of cnidæ of oval shape, and measuring from ·005 to ·007 mm.

The pericardium and the contained heart were typical, and also the yellowish-white *renal syrinx* situated in the neighbourhood of the renal pore.

The yellowish *hermaphrodite gland* has a length of 7 mm. and a breadth and height of about 3·5 mm.; it is conical in shape; along the dorsal surface there is a wide and deep furrow for the main hepatic duct; the gland shows traces of division into halves, each composed of a considerable number of lobes, which are themselves divided into smaller lobules. The lobules have the usual structure, and the testicular portion, which is white in colour, is easily distinguished from the yellow ovarian follicles. The somewhat thick *hermaphrodite duct* which takes its rise from the hollowed-out anterior part of the gland, is white in colour, and of inconsiderable length, gradually passing into the ampulla.—The *anterior genital mass* is large, 5·5 mm. long, 4 mm. broad, and 3·5 mm. high; about the middle of the upper surface there is a square saddle-shaped hollow for the stomach. The opaque whitish-yellow *ampulla* of the hermaphrodite duct is about five times the thickness of the duct itself; it forms the posterior end of the genital mass, and is coiled upon itself; when unrolled it measures about 12 mm. long, by ·8 mm. in diameter. The male branch immediately becomes the coiled *vas deferens*; this is very thick walled and white in colour, when unrolled measuring some 13 mm. in length and ·6 mm. in diameter throughout its whole extent; it passes above into the excavated base of the (invaginated) *penis*. The penis is short and sac-like, about 2·5 mm. in length, yellowish-white in colour; the cavity of the præputium is almost entirely filled by the strongly developed conical yellowish glans, which is entirely unarmed. The *vesicula seminalis* is spherical. The *mucous gland* shows many coils, and is chalk-white; the *albuminiparous gland* is dirty yellow.

There is hardly any doubt that this species is a *Rizzolia*; since it agrees so closely with that genus in the character of the mandibles, in the armature of the tongue, and the structure of the penis; the ringed form of the rhinophoria is probably merely dependent upon contraction. The peculiar structure of the denticles of the mandibular process will perhaps render this species easier of recognition.

Scyllæa, Linné.

Scyllæa, Linné, Syst. Nat., ed. x., 1758, vol. i. pp. 644, 656.
„ Cuvier, Ann. du Mus., t. vi., 1805, p. 416, pl. xix.
„ Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft viii. 1875, pp. 315–343.
„ Bergh, Beitr. z. Kenntn. d. Moll. des Sargassomeeres, Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxi., 1871, pp. 1288–1293.
„ Bergh, Beitr. z. Kenntn. d. japan. Nudibr. I., *loc. cit.*, Bd. xxx., 1880, pp. 166–172.

Corpus oblongum, compressum. Tentacula propria nulla; rhinophoria compressa, auriformia, supra calyculata cum clavo parvo perfoliato. Dorsum angustum; utrinque papillis duabus foliaceis ut plurimum repandis, pagina interna arbusculis branchialibus præditis; postice cum crista (caudali) elevata, utroque latere arbusculis branchialibus instructa. Podarium angustum, antice rotundatum.

Mandibulæ applanatæ, processu masticatorio magno margine minute tuberculato. Lingua lata; rhachide dente utrinque denticulato; pleuris multidentatis, dentibus utrinque sed inæqualiter denticulatis. Ventriculus lamellis masticatoriis armatus. Glandulæ hermaphrodisiacæ (1–3) discretæ. Penis inermis.

These animals have been known from the time of Seba (1734) and Linné, but these two authors described them erroneously, mistaking the upper for the under side. Although this error was corrected by Osbeck (1757), and by Forskål (1775), the nature and systematic position of the genus was doubtful until the time of Cuvier (1798, 1805). Recently the genus has become better known through my three Memoirs just cited (1871–1880).

The external appearance of *Scyllæa* is remarkable, and it is at once distinguishable from any other known genus by the character of the rhinophoria and of the large dorsal foliaceous papillæ, and by the caudal crest covered like the inside of the papillæ with branchial tufts.—The structure of the mandibles and radula is also peculiar; a masticatory stomach is present. The hermaphrodite gland is divided into three distinct lobes; the penis, as in allied genera, is unarmed.

Scyllæa inhabits the tropical and subtropical portions of the ocean; it feeds upon Hydroids (especially Campanulariaceæ), and is found creeping over the surface of Fucoids in search of its food; but it also swims about in the sea. The spawn of the typical form has been seen.

Several species have been described, or at least named, some of which will no doubt eventually prove to belong to one circumæquatorial species.

The following is a list of these species:—

1. *Scyllæa pelagica*, Linné.
   Atlantic Ocean.

Scyllæa pelagica, var. *marginata*, Bergh.

? *Scyllæa grayæ*, Adams.

Atlantic Ocean.

Scyllæa pelagica, var. *ghomfodensis* (Forskål).

Red Sea.

Scyllæa pelagica, var. *sinensis*, Bergh.

Chinese Sea.

Scyllæa pelagica, var. *orientalis*, Bergh.

? *Scyllæa ghomfodensis*, Quoy et Gaimard.

Philippine Sea.

2. *Scyllæa fulva*, Quoy et Gaimard.

Pacific Ocean.

3. *Scyllæa marmorata*, Alder and Hancock.

Indian Ocean.

4. *Scyllæa quoyii*, Gray.

Indian Ocean.

5. *Scyllæa elegantula*, Bergh.

Philippine Sea.

6. *Scyllæa viridis*, Alder and Hancock.

Indian Ocean.

7. *Scyllæa bicolor*, Bergh.

Japanese Sea.

8. *Scyllæa hookeri*, Gray.

Pacific Ocean

9. *Scyllæa edwardsii*, Verrill.

Scyllæa edwardsii, Verrill, Amer. Journ. Sci. and Arts, vol. xvi., 1878, p. 211.
" " " Catal. of Marine Moll., Trans. Connect. Acad., vol. v., part 2, 1882, p. 550.

Atlantic Ocean.

Scyllæa pelagica, Linné (Pl. XI. fig. 20).

Scyllæa pelagica, L., Bergh, Beitr. z. Kenntn. d. Moll. des Sargassomeeres, *loc. cit.*, pp. 1288–1293.

„ „ L., Bergh, Malacolog. Untersuch., *loc. cit.*, pp. 319–334, Taf. xl., xlii., xliii. figs. 1–6.

Five specimens were taken in the Atlantic, on the surface, attached to a Fucoid, May 4th and 5th, 1876.

The larger individual measured 3·5 cm. in length, by 1·2 cm. in height, and ·75 cm. in breadth. The height of the rhinophoria was 5·5 mm., of the first pair of dorsal papillæ 7·5 mm., of the second 7 mm., of the caudal crest 5·5 mm. The colour of the animal is a dirty yellowish-white.

The *form* of the body was quite as usual, and also the *head* and *rhinophoria;* the club of the latter was provided with about seven leaves. The branchiæ were grouped in the following way. Nine or ten more or less distinctly separated tufts were situated on the inside of the first pair of papillæ; thirteen or fourteen rather smaller branchiæ on the inside of the second pair, and on the sides of the caudal crest were four to five small branchial tufts, and in addition a few small tufts were found in the neighbourhood of the interpapillary margin. The anal and genital papilla together with the renal pore were perfectly typical, as also the foot.

The visceral cavity extends about as far as the anterior end of the caudal crest.

The *central nervous system* presented a commissure no longer than in the example already figured by me;[1] in no other specimen did I ever see it much longer; the three portions of which the commissure is made up were easily to be distinguished; the subcerebral commissure appears never to be distinct.[2] The eyes and otocysts were as usual.

The *bulbus pharyngeus* is about 4·6 mm. long, and of the usual form; the *mandibles* have already been described by me as well as the peculiar armature of the masticatory edge which can easily be rubbed off, thus leaving the jaw smooth. The *tongue* presents its usual appearance, the radula containing seven series of teeth and sixteen series within the sheath, the total being therefore twenty-three rows. In the posterior row of the tongue there are thirty-six lateral teeth (on either side of the median tooth); thirty-nine in the posterior row of those within the sheath. The form of the teeth presented no peculiarities. The salivary glands were quite typical.

The *œsophagus* and anterior division of the *stomach* were typical, the second division possessed fourteen strong plates; the characters of the intestine and *liver*, with its two divisions and the ramified hepatic tubes were as already described by me. The *renal system* presented no deviations from the structure which has been described by Hancock and myself.

[1] Malacolog. Untersuch., *loc. cit.*, Taf. xl. figs. (13), 14.

[2] H. v. Jhering describes the commissures as much longer and the subcerebral as distinct. Vergl. Anat. d. Nervensyst. d. Moll., 1877, p. 176.

The *hermaphrodite gland* is made up of six distinct lobes; three are situated posteriorly (the hindermost is somewhat larger than the other two), two median lobes are situated under the posterior liver, and an anterior just at the hinder end of the *anterior genital mass*. This last large one measures about 7 mm.; the ampulla of the hermaphrodite duct is dirty yellow, somewhat sausage-shaped, it is bent upon itself, and when straight it measures about 15 mm.; the penis is conical, about 2·5 mm. long, the glans nearly fills the præputium (Pl. XI. fig. 20, *b*); the spermatheca is of the usual small size; the mucous gland is whitish, the albuminiparous gland brownish in colour.

Bornella, Gray.

Bornella, Gray, Figures of molluscous animals, vol. iv., 1850, p. 107.
„ „ Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft vii., 1874, p. 287–308, Taf. xxxvi.–xxxviii.

Corpus compressum. Tentacula breve pedicellata, e conis vel cylindris humilibus seriebus curvatis dispositis formata. Rhinophoria papillis dorsalibus anticis quasi connata; vagina rhinophorialis margine digitato, clavus perfoliatus. Margo dorsalis utrinque papillis fortioribus, apice digitatis, infra branchiferis continuatus; branchiæ compositæ, externæ et internæ, externæ sæpius appendicibus simplicibus defensæ. Anus latero-dorsalis. Podarium angustius, antice rotundatum.

Armatura labialis peculiaris, quasi squamosa. Mandibulæ fortiores, compressæ. Radula dentibus medianis fortioribus, margine lævi vel denticulato; dentibus lateralibus compluribus corpore elongato, hamo obliquo, elongato, margine lævi.—Ventriculus secundus spinis seriatis armatus. Penis annulo spinarum armatus.

The genus *Bornella* was created by Gray in 1850, from a specimen brought back by H. and A. Adams, who accompanied the expedition of the "Samarang," or perhaps from the figure of the animal given by these authors.[1] About the same time (1848 or 1850) the genus was a little more fully described by Adams and Reeve,[2] the description in "Gray's Guide" being indeed hardly sufficient for recognition of the animal. Hancock (1864, 1866) made considerable addition to our knowledge of this genus which a few years later (1874) was described by me in detail in my monograph.

These animals agree in their outward form with the Dendronotidæ, being, like them, compressed. At the front are the peculiar *tentacles* which are provided with a short stalk; this has a number of short conical or cylindrical projections arranged in two rows. The *rhinophoria* are fused throughout their whole length with a process which extends beyond them, and is like one of the dorsal papillæ. The sheath of the rhinophorium is divided above into finger-shaped branches; the club being strongly perfoliated.

[1] Bergh, *loc. cit.*, p. 287, notes 2, 3.
[2] Bergh, *loc. cit.*, p. 287, note 3.

The *dorsal margin* is prolonged into several *papillæ*, which at the free upper end are divided into several (4–2) points, and at the base bear several tripinnate *branchiæ*, which on the outer side are sometimes protected by special finger-shaped processes. The *anus* is latero-dorsal in position, and lies just in front of the second dorsal papilla. The *foot* is small and rounded anteriorly.

The *bulbus pharyngeus* is not large, and is to a great extent formed by a powerful muscular mass as in the Pleurophyllidiadæ and Phylliroidæ. The thick *labial disk* has a special scale-like armature. The *mandibles* are large, powerful and compressed, without any masticatory process. The *tongue* is high; its armature consists of a median tooth, which is not large, and number of lateral teeth, the latter being always smooth, the former occasionally denticulate. The *stomach* has two divisions, *the hinder of which is provided with a series of chitinous spines* in its interior. The gut is short. With the exception of one form (*Bornella excepta*), all the species of this genus which have been hitherto examined possess a branched liver which sends prolongations into most of the papillæ, entering them more or less at the base. The *penis* has an oblique girdle of straight or curved *thorny processes*.

The genus *Bornella* seems to be confined to the tropics, and has always been found among Fucoids; of its habits Adams and Pease have given some account; the animals are said to creep "briskly" about over the surface of Fucoids; and sometimes to swim freely in the water by lateral movements of the body.

Only the following species[1] have been hitherto described:—

1. *Bornella digitata* (Adams and Reeve), Bergh.
   Indian Ocean.

2. *Bornella calcarata* (Mörch), Bergh.
   Atlantic Ocean.

3. *Bornella arborescens* (Pease), Bergh.
   Bergh, Neue Nacktschnecken d. Südsee. II. Journ. d. Mus. Godeffroy, Heft vi., 1874, pp. 96–102, Taf. i. figs. 3–4; Taf. ii. figs. 30–33; Taf. iv. figs. 1–28.

4. *Bornella excepta*, n. sp.
   Pacific Ocean.

5. *Bornella adamsii*, Gray?
   Indian Ocean.

6. *Bornella hancockana*, Kelaart?
   Indian Ocean.

[1] Bergh, *loc. cit.*, pp. 288–289.

7. *Bornella hermanni*, Angas ?

Journ. de Conchyl., sér. 3, t. iv., 1864, p. 61, pl. vi. fig. 1.

Pacific Ocean.

8. *Bornella semperi*, Crosse ?[1]

Bergh, Malacolog. Untersuch., *loc. cit.*, Heft. i., 1870, Taf. i. figs. 3–5.

Philippine Sea.

9. *Bornella caledonica*, Crosse ?

Journ. de Conchyl., sér. 3, t. xv., 1875, p. 318, pl. xii. fig. 10.

Pacific Ocean.

Bornella excepta, n. sp. (Pl. VII. figs. 13–22; Pl. VIII. figs. 1–13).

Color animalis ?

Rhinophoria basi non appendiculata, parte posteriori (papillari) apice quadrifida; papillæ dorsales utrinque 5, infra branchiferæ, apice bi- vel tri-fidæ; branchiæ externæ, appendiculatæ, internæ sine appendice.

Dentes (linguæ) mediani margine denticulato. Hamuli penis erecti.

Habitat.—Pacific.

One individual of this colossal species was taken in September 1874 in the Arafura Sea; it had been treated with picro-sulphuric acid and preserved in alcohol, and was therefore in very good condition for study.

Its *length* was 6 cm., height of the body proper 13 mm., and diameter 8 mm.; the height of the frontal papillæ was 4·5 mm., of the whole rhinophoria 11 mm., and of the anterior dorsal papillæ quite 12 mm.; the breadth of the foot 5 mm. The *colour* was a clear brownish-yellow (owing no doubt partly to the picric acid); the liver was visible through the sides of the body, and on the right side the greenish-grey intestine also.

The *form* of the body was quite as usual. It was stretched and somewhat compressed, broader above than below. The *head* (Pl. VII. fig. 13) rather large, marked off from the

[1] The creation of this species is a good example of the "species manufacturing" of many writers. I myself, who have worked at the genus *Bornella* itself and the literature, found among the drawings of Semper a *Bornella* which is quite unrecognisable, and which therefore I quote as "*Bornella*, sp., Semper MSS." Crosse, who has no proper notion of the structure of *Bornella*, explains in an entirely worthless memoir (Note sur les genres Bornella et Placobranchus, *Journ. d. Conchyl.*, sér. 3, t. xv., 1875, pp. 322–325) this figure as a new species, *Bornella semperi*. His method of investigating such forms is also illustrated by the creation of another species, *Bornella caledonica* (Nudibr. de la Nouvelle Calédonie, *Journ. d. Conchyl.*, sér. 3, t. xv., 1875, p. 318, pl. xii. fig. 10). Writers of this kind are a burden to science, and Malacology has had enough of them.

foot beneath by a furrow, and from the dorsal portion of the body by a shallow groove behind the rhinophoria. The anterior extremity slants steeply downwards and backwards. The *mouth* (fig. 13, *a*) is provided with a pair of thick lips, which unite above and are connected below by a transverse piece; internally are a number of folds and furrows which converge to the wide mouth opening. On the side of the head, not far from the lips, are the peculiar *tentacles* (fig. 13, *b*), from fifteen (on the right side) to sixteen (on the left) in number, almost cylindrico-conical in shape, and measuring about 2·5 mm. in length; these are arranged in a double or triple series, and take their origin from a low crescentic basal piece which is a little higher behind. Behind these are the obliquely situated powerful compressed *rhinophoria* (fig. 13, *c*), which are attached to the "neck" and very close to each other. From the long but narrow base the powerful stalk takes its origin, which at its upper end is slightly broader and thicker (breadth 7 mm., thickness 3 mm.); the outer portion of the stalk ends in the rhinophore proper, while the inner part (fig. 13, *d*) is continued upwards into the papillary portion. The rhinophore has the customary sheath with its three finger-like processes (fig. 13, *c*, and fig. 14); these all measure about 3 mm., and are rather flattened. The club of the rhinophore is some 3 mm. high, and has 40 or 50 broad leaves on both sides.[1] The upper margin of the papillary part has four compressed points, of which the outermost but one is the largest. The eyes are not visible from the exterior. The *dorsal surface* is for the most part rather broad, and is narrower at the posterior extremity only; it is rounded and not marked off from the sides of the body. From the margin of the back spring the five strong *branchia-bearing papillæ;* the distance between the rhinophoria and the first pair of papillæ is rather long, nearly as long as the distance between the first and second pair of papillæ, or the second and third; the distance between the third and fourth pairs is a little shorter, and soon after this follows the fifth pair. The papillæ are situated almost exactly opposite each other; only the fifth on the right side is somewhat further back and also smaller than its fellow on the left side; in other respects the two corresponding papillæ were nearly of equal size. In the middle of the first inter-papillary space (a little nearer to the second papilla), near the right dorsal margin, is the slightly prominent *anal papilla*, in front of which is the fine *renal pore*. The papillæ are rather sharply differentiated from the dorsal wall, on which they are set somewhat obliquely; each papilla is separated from its fellow by a rather narrow space, which in the case of the fourth papilla has quite disappeared. The *first papilla* (Pl. VIII. fig. 1) is a little compressed, and continuous above with the three likewise rather compressed finger-like processes, of which the middle one is the largest. Above the base, in the neighbourhood of the anterior and posterior margins on the outer side, is a small branchial tuft, protected by a cylindrical finger-like process; similarly on the inside, but rather higher, are tufts, but without a covering. The branchiæ are irregularly tri- and quadri-pinnate, and are provided with a short stem; the leaves

[1] Bergh, Malacolog. Untersuch., *loc. cit.*, p. 290, Taf. xxxvii. fig. 13.

are rather flattened. The *second* papilla is rather smaller than the first, but otherwise just like it; the left hand organ is also prolonged but into only two finger-like processes, and has on the inside a large posterior, and a small anterior branchia. The *third* papilla is smaller still, and is prolonged into one or two thick finger-like processes above, with the usual two branchiæ on the outside, but only one on the inside. The *fourth* papilla is rather low (4·5 mm. high), ending above in two points, with one branchia on the inside (unprovided with a cirrus). The *fifth* papilla is lower still, and prolonged above into a simple or slightly forked extremity; on the outer side of the right hand one is a small branchia with a cirrus, which is absent from the left hand branchia. The short *tail* (3 mm. long) has a high keel, ending in a point above about as high as the length of the tail.—The sides of the body are high, but decrease in height from the level of the third papilla backwards; a little below the anterior margin of the first papilla on the right is the eyelet-like wrinkled *genital aperture*.—The *foot* is rather narrow, slightly broader in front than elsewhere; from the region of the third papilla backwards it rapidly narrows; the marginal brim is about 3 mm. broad; the anterior margin (Pl. VII. fig. 13) has a superficial furrow.

The cavity of the body extends to about the region of the fourth papilla, it is fastened to the body-wall by septa of connective tissue, and by the renal tubes.

The position of the intestines has been already described by me.[1]

The *central nervous system* has the cerebro-pleural ganglia very closely united to each other; their two divisions but slightly distinguishable, the anterior is more flattened and slanting in front, the posterior division is thicker. The pedal ganglia are not much smaller than the cerebro-pleural, and are situated obliquely below them; they are, however, not so thick; from each ganglion are given off four stout nerves, bifurcated nearly from the root. The pedal commissure is barely one-third of the breadth of the ganglia themselves. In front of this commissure are the separated pleural and subcerebral commissures, and behind the pedal apparently a sympathetic. The buccal ganglia are rather large and rounded; they are united by a commissure, which is at least one-third the diameter of the ganglia; the gastro-œsophageal ganglia are about one-fourth the size of the buccal, and are provided with a short stalk. The nervus opticus is quite twice as long as the diameter of the central nervous system; that portion of it nearest the eye shows black pigment; the nervus olfactorius dilates into a small ganglion, nearly as big as the buccal ganglion at the base of the club of the rhinophore.

The *eyes* are large, the lens[2] yellow in colour, the pigment black. I did not succeed in discovering the otocyst. There were no spicules in the leaves of the rhinophoria, nor in the skin; in the latter there were, on the contrary, masses of variously sized unicellular

[1] Bergh, *loc. cit.*, p. 292.

[2] The lens appeared in both eyes to be composed of a number of spherical pyramids; but this may have been a *post-mortem* appearance.

glands scattered thickly about and arranged in groups. The fibres and lamellæ of the *interstitial connective tissue* showed the usual structure.

The mouth tube was as usual.[1] The *bulbus pharyngeus* of the ordinary form, a little depressed, and about 6 mm. long by 5 mm. broad and 4 mm. high. The musculi retractores superiores (mediani and laterales) as in other species;[2] they belong properly to the mouth tube. The *labial disk* is large and very thick; it is quite similar to that of other species;[3] at the anterior margin the *labial plates* are of a dirty yellow colour, above and below they nearly meet in the median line, the surface is finely striated; their length is 3·5 mm., breadth not quite 2 mm.[4] They displayed along the middle of their length the usual rows of small scales (Pl. VII. fig. 15), measuring about ·007 mm. in breadth; at the anterior margin there were a number of small columns, about ·04–·08 mm. in length.[5] Behind the labial disk is a large *muscular mass upon the fore part of the mandibles*, consisting of the two usual layers.[6] Behind this again are the *mandibles* (Pl. VIII. figs. 2, 3), of a chitinous yellow colour, deepening to brownish-black upon the masticatory edge; each measures 3·5 mm. in length, 2·25 in breadth, and ·5 mm. in height. In shape they resemble those of other *Bornellæ;* on the inside beneath the hinge and near the masticatory edge, there is a triangular excavation (fig. 3, *b*); the masticatory edge (fig. 2, *b*) is roundly indented; there is no masticatory process. The mouth slit is narrow, the accessory buccal cavities small. The buccal cavity is narrow and entirely occupied by the high compressed tongue. The *tongue* is provided with a narrow radula, brownish-yellow in colour, and not excavated along the rhachis; it is made up of seventeen *rows of teeth* on the high anterior margin, and three on the shorter upper margin;[7] farther back, within the stout somewhat longer radula-sheath, there were nineteen developed and two undeveloped series of plates, making a total of forty-one. The most anterior (lowest) row (of the tongue) is only represented by the median tooth; the next series consists of a median tooth, and one lateral tooth on one side, and seven on the other; the succeeding rows are more complete, the first fourteen rows still incomplete and provided with a considerable number of worn-out teeth (Pl. VII. fig. 16). The *median teeth* (Pl. VIII. figs. 4, 5, 6, 7, *a*) are reddish-yellow, almost chestnut in colour; the *lateral teeth* clear yellow, darker at the base. The breadth and height of the median teeth at the middle of the tongue were each about ·12 mm., and those, situated posteriorly, appeared to measure about the same. The length of the hook of the lateral plates averages about ·1 mm. The *median teeth* (figs. 4–7) have the usual form; on

[1] Bergh, *loc. cit.*, Taf. xxxvi. figs. 9, *c*, 10, *c*.

[2] *Loc. cit.*, figs. 9, *aa*, 10, *a*—fig. 9, *bb*.

[3] *Loc. cit.*, p. 294.

[4] *Loc. cit.*, Taf. xxxvi. figs. 11–14, *f*.

[5] A vast quantity of cnidæ were adherent to the labial disk.

[6] Bergh, *loc. cit.*, p. 293.

[7] The rhachis of the tongue was covered with a greyish mass, which proved to be made up of densely entangled masses of cnidæ.

either side of the terminal point are twelve or thirteen denticles,—only ten or eleven in the most anterior teeth. The *lateral teeth* (figs. 7, *b*,*c*, 8) consist as usual of a long basal portion, and a straight or slightly bent smooth-edged hook, which terminates in a fine point.[1] The number of lateral plates on the tongue is about seventeen or eighteen on each side; farther back within the sheath there are as many as nineteen. The innermost lateral plate (fig. 7, *b*,*b*) is very minute, the hook measuring scarcely ·007 mm.; the next one has a far more strongly developed "hook," some ·015 mm. high, and the eight or nine that follow gradually increase in size; the next four or five are of about the same length as the last; the one that follows these has a rather shorter "hook," and finally, the two outermost (fig. 8, *a*) are quite short, the length of the hook not exceeding ·025—·035 and ·0015 mm.

The yellowish *salivary glands* are flat and not very compact, meeting each other in the middle line; they are situated at the anterior edge, and at the lower surface of the first stomach. The ducts were quite as usual.

The *œsophagus* (Pl. VIII. fig. 9, *a*) is rather short (only 5·5 mm. long) and wide, passing behind into the thin walled *first stomach* (fig. 9, *b*), which is about double its breadth, and round in shape; its length is about 4 mm.; on the upper surface of this open the two lobes of the liver, one on each side, that on the left being somewhat larger than the right hand one. Not far from the aperture of the left liver, just at the junction of the first and second stomachs, is the opening of the somewhat wider main bile duct (fig. 9, *c*). The interior of the first stomach has a number of longitudinal folds, which become higher behind, and partly terminate at the opening of the bile ducts; the openings of the two livers were guarded by a valve-like fold. The first stomach is inclined at a somewhat oblique angle to the *second stomach* (fig. 9, *f*), which is spindle-shaped, and 8 mm. in length by 3·5 mm. in width; it is greyish in colour, and shows a number of fine longitudinal lines. This stomach has a largish number (perhaps eighty) of folds which extend from one aperture to the other; they are situated at short irregular intervals from each other, and bear a number of black *prickles* (fig. 10), either standing perpendicularly or directed backwards; these prickles attain a height of ·8 mm., and are of a dirty brown or blackish-brown colour; in form they are straight and cylindrical, sometimes rounded off or swollen at the upper extremity; their structure (fig. 11) is fibrous, as in other species of the genus *Bornella*,[2] and fissile; their interior showed, at least in the clearer prickles, a cellular structure (fig. 11). The first portion of the *gut* (fig. 9, *g*) is about as long and broad as the second stomach, passing by a narrow opening (fig. 9, *h*) into the rectum (fig. 9, *i*), the posterior portion of which is somewhat narrow, and opens on the anal papilla, behind the second section of the hermaphrodite gland; the length of

[1] Among the worn-out teeth were several that displayed a peculiar brownish colour upon the end of the hook (Pl. VII. fig. 16).

[2] Bergh, *loc. cit.*, p. 293.

the whole intestine is about 2 cm. The interior of the first division of the intestine is traversed by numerous fine longitudinal folds, one of which is much stronger than the rest, and passes through the small cylindrical portion which joins the anterior and posterior divisions of the intestine, it can be recognised from the outside. In the rectum the folds are not so strongly developed. The *contents* of the whole *digestive tract* form a brownish-black mass of unrecognisable animal débris; in the stomach there were fragments of Hydroid polyps, Copepoda, and torn prickles of the stomach itself.

The *two anterior livers* (fig. 9, *c,c*) are small, the right hand one is formed of two lobes, and is a little larger than the left hand one (length 5 mm.); both open into the first stomach, into which also opens the *chief mass of the liver* (fig. 9, *d*) by its short wide bile duct (fig. 9, *e*). The liver measures 3 cm. in length, and has a diameter of 5 mm. anteriorly, 2·5 mm. posteriorly, and about 7 mm. in the middle; it was a trifle flattened, its colour like that of the anterior livers, brownish-blackish-grey; it is divided into a number of disk-like lobes, by fewer or more superficial transverse furrows. It has no traces whatever of any prolongations into the papillæ, nor are there any traces on the body-wall of cavities at the base of the papillæ for the reception of such diverticula. The walls of the liver are thin and delicate, and show a quantity of transverse anastomosing trabeculæ; the cavity extends throughout the liver. The contents of the liver were precisely similar in character and appearance to the contents of the rest of the alimentary canal.

The *heart* is like that of other species of *Bornella*,[1] the ventricle quite spherical, and about 2 mm. in size. The course of the posterior aorta has been already described by me.[2] Transverse sections of the dorsal papillæ showed an opening on either side for the arteria and vena papillaris (branchialis).

The *renal syrinx* was attached to the outer side of the rectum; it was pear-shaped, and had a length of 2·5 mm. Its colour was yellowish-white and the longitudinal folds were quite visible from the outside. The *urinary chamber* has been already described by Hancock and myself;[3] its breadth is ·4–·5 mm.; it gives out numerous branches from both sides, and shows the usual knobs. The strongly branched *renal tubes* (fig. 12) surround the intestines, and contrast by their whitish colour with the liver and hermaphrodite gland.

The rather pale ochre-yellow *hermaphrodite gland* is 14 mm. long by 7 mm. broad, and 3 mm. high, and covers the upper and (further back) the left side of the anterior half of the liver, and is somewhat sunk within its surface, but is marked out from it by the contrast of colour; it consists of nine not quite equal lobes, all of which, with the exception of the foremost, are paired. The lobes are roundish (fig. 13), and strongly facetted; the free surface is finely granulated, the granulation being not so distinct upon the facets. The structure (Pl. XVII. fig. 17) of the lobules is as usual; the white club-shaped

[1] Bergh., *loc. cit.*, p. 298, pl. xxxvii. fig. 8. [2] Idem. [3] Bergh, *loc. cit.*, p. 299.

testicular portion bears numerous and variously sized ovarian follicles. The *hermaphrodite duct* takes its course along the furrow on the under surface of the gland, and is formed of numerous ductules (fig. 17, *a*), which unite together; it passes over to the posterior portion of the mucous gland and swells out into an ampulla.—The *anterior genital mass* is longish and rounded-subquadrangular in shape; it is more convex upon the upper side than upon the lower; its length is 9 mm., breadth 7 mm., and 5·5 mm. in height. On the upper side are the windings of the yellowish, strong vas deferens, which ends in front in the large penis; the latter forms the anterior end, and is generally more than one-half of the genital mass. The backward continuation of the vas deferens passes round the left margin of the genital mass, and runs along its under surface as far as the ampulla of the hermaphrodite duct, which latter forms the hinder end of the genital mass. The *ampulla*, which is situated beneath the hinder end of the genital mass, is yellowish in colour, small, and rather thin. The *vas deferens* is long and strong, its length is 4·5 cm., and the diameter everywhere 1·5–1 mm.; the longer hinder part of it (fig. 20, *c*) probably acts as a prostate gland, it is yellowish in colour, but somewhat less stout than the anterior muscular portion (fig. 20, *b*), which is about 1·6 mm. long; these two divisions are separated by a constriction (fig. 20, *a*). The *penis* is short and sac-like, slightly arched, 8 mm. in length with a diameter of 4 mm.; the wall is rather thick, the structure of the whole organ resembles that of other species of *Bornella*. The short inferior portion is unevenly wrinkled on the inside; the remainder is smoother and lies between two similar stout *festoons*. These structures are usually 1–1·5 mm. in thickness and the same height; they unite with each other below (fig. 19) and above (fig. 18) the circular orifice (fig. 18, *a*) of the vas deferens; they have the margins as well as the surface somewhat wrinkled. On the margin are developed a number of black *spines* (altogether about 220) arranged in a single row. These spines (figs. 21, 22) are found in furrows at the rounded summit of cones, about twice as high as the spines themselves; the tissue of these cones is prolonged for a short distance up the axis of the spines, which are therefore very firmly attached, and do not easily break off. The straight, slightly S-shaped spines are of the average height of ·28 mm.; their contour is rounded; they are broader below, and end in a point above. The *spermatheca* is pear-shaped, about 2 mm. long, and lying on the right side of the mucous gland, it was distended with semen; its duct, hardly as long as the organ itself, opens into the vestibulum genitale close to the opening of the *mucous gland*. This latter organ is yellowish, but chalky white on the under surface and on the left side; at the hinder end it has a large brown twist, which is blackish-blue above; the efferent duct is short, and has the usual fold.

The species I have just described is strikingly different from the three other previously examined species of *Bornella* (*Bornella calcarata* from the Antilles Sea, *Bornella digitata*

and *Bornella arborescens* from the Southern Sea).[1] It comes nearest, however, to the last-mentioned of the three, but differs sufficiently in the form of the dorsal papillæ and the character of the branchiæ and their appendages; it agrees with these last two species in possessing denticulated median plates in the radula, but the shape of the spines of the penis is quite different.

Family Tritoniadæ.

This Family is in some respects intermediate between the kladohepatic Nudibranchiata (Æolidiadæ) and the holohepatic Nudibranchiata (Doridida), but presents more affinities to the former group. With the latter it agrees in the possession of a simple unbranched liver, and in the absence of a sanguineous gland and of a spermatocyst. It contains but few types, which differ but slightly from each other, both as regards outward form and internal structure.

The *body* is elongated and slightly quadrangular, the anterior portion is broader, the posterior narrowed; the dorsal surface is flattened and granular in appearance; the sides of the body are high and perpendicular; the foot is broad. At the anterior extremity the back acquires a crescentic prominence—the *frontal veil;* the free margin of this is covered with small papillæ, or with simple, sometimes compound, finger-shaped processes; the outer extremity is thickened and forms a spoon-shaped structure—the *tentacle* proper. The *rhinophoria* are situated on the "neck," just behind the frontal veil. The sheath of the rhinophoria is tubular and slightly depressed, with a recurved margin; the sword-knot-shaped club is retractile, the central portion has a flattened upper surface, the margin is set with erect feather-like processes, the rhachis of the hindermost process is continued into a rather strongly developed papilla. On the slightly prominent margin of the back there are a number of variously sized *branchial tufts,* arranged one behind the other in a single series; they are low, more or less arborescent, tri- or quadripinnate, and are set on a short stalk. The *anal papilla* and the *renal aperture* are situated close to each other about the middle of the body on the right side. The *foot* is rather broad and rounded at its anterior end; the tail is very short.

The *bulbus pharyngeus* is strongly developed, and resembles that of the Pleurophyllidiadæ, as do also the *mandibles* especially. The *tongue* is well developed; the radula consists of a median tooth, on each side of which is a longer (*Tritonia*) or a shorter (*Candiella, Marionia*) series of uncinate lateral teeth; the first lateral tooth always differs from the rest. The stomach is generally unarmed, but in *Marionia* it is provided with a belt of hard longitudinal plates. The *liver* is large, and forms a short conical mass; the anterior part either shows traces of becoming separated from the rest or is actually separate (*Marionia*). The liver sends off no branches into the dorsal papillæ

[1] For a description of these species, *see* Bgh., *loc. cit.*, pp. 289, 301.

as it does in *Scyllæa*, and there is no trace of the peculiar relations between the liver and the branchial organs which are seen in the Kladohepatic Nudibranchiata. There is no trace of the *sanguineous gland*, which is characteristic of the holohepatic Nudibranchiata. The *hermaphrodite gland*, as in the last-mentioned group, surrounds the liver, and is not separate from it as in *Scyllæa*. The *spermatheca* is large, but there is no spermatocyst present. The *penis* is unarmed.

The Family of the Tritoniadæ as now known[1] includes two (or three) generic groups. Firstly, *Tritonia*, which may again be divided into (1) *Tritonia*, characterised by the great development of papillæ upon the frontal margin and by the radula possessing a great number of lateral teeth; and (2) *Candiella*, characterised by the development of finger-shaped processes upon the frontal margin, and by the smaller number of lateral teeth on the radula. Secondly *Marionia*, and the somewhat doubtful genus *Hancockia* of Gosse,[2] which perhaps belongs to this family also.

The Tritoniadæ are carnivorous animals, feeding chiefly on Alcyonarians and allied forms. The *spawn* of some species of *Tritonia* from the North Atlantic has been described. Nothing is known about their development; Gosse simply mentions the Nautiloid shell in *Hancockia*.

I. *Tritonia*, Cuvier.

Limbus frontalis papilligerus vel digitatus. Ventriculus non armatus.

The Tritoniæ proper differ from the Marioniæ by the simple papillæ of the frontal veil, and by the stomach being unarmed. The genus may be divided into two subgenera.[3]

Sub-genus 1. *Tritonia*.

Margo veli frontalis papilliger. Radula dentibus lateralibus numerosis.

The genus contains the following species:—

1. *Tritonia hombergi*, Cuvier.
   Atlantic Ocean, Mediterranean.
2. *Tritonia rubra*, Leuckart.
   Red Sea.
3. *Tritonia tetraquetra* (Pallas).
   Pacific Ocean, neighbourhood of Aleutian Islands.

[1] *Cf.* My monograph of the Tritoniadæ, which will shortly be published, and which will form Heft xv. of my Malacologische Untersuchungen (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.).

[2] P. H. Gosse, On Hancockia eudactylota, *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xx., 1877, pp. 316–319, pl. xi.

[3] *Cf.* My monograph on Tritoniadæ, *loc. cit.*

4. *Tritonia palmeri*, Cooper.
   Pacific Ocean.

5. *Tritonia reticulata*, Bergh.
   Japanese Sea.

6. *Tritonia hawaiensis*, Pease.
   Pacific Ocean, neighbourhood of Sandwich Islands.

7. *Tritonia pallida*, Stimpson.
   Cape of Good Hope.

8. *Tritonia challengeriana*, n. sp.
   Pacific off Patagonia.

9. *Tritonia* (?) *cucullata* (Couth.), Gould.
   Western Atlantic off Rio Janeiro.

Sub-genus 2. *Candiella*, Gray.

Margo veli frontalis digitatus. Radula dentibus lateralibus non numerosis.

The genus contains the following species :—

1. *Candiella plebeia*, Johnston.
   Atlantic.

2. *Candiella lineata*, Alder and Hancock.
   Atlantic.

3. *Candiella* (*Duvaucelia*) *gracilis* (Risso).
   Mediterranean.

4. *Candiella manicata* (Deshayes) = ? *Nemocephala marmorata*, A. Costa.
   Mediterranean.

Tritonia challengeriana, n. sp. (Pl. XI. figs. 16–19; Pl. XII. figs. 1–8).

Habitat.—Southern Pacific. Off the coast of Patagonia.

Two specimens of this interesting form were dredged at Station 308, off the west coast of Patagonia, from a depth of 175 fathoms, on January 5, 1876. Both specimens were nearly of the same size, and were well preserved. I dissected both.

The length of the animal is about 3·5 to 4 cm., the height of the body proper 1·2–1·4 cm., the breadth 1·5–1·8 cm.; the breadth of the frontal veil 8–10 mm., the length of

the rhinophorial sheaths 2 mm., of the rhinophoria 2 mm.; the length of the branchial tufts from ·5–2 mm.; the breadth of the foot 6–8 mm. The *colour* differed in the two specimens, one being whitish-yellow and the other more grey; in both the rhinophoria were of a whitish tint, the branchial tufts, anal and genital papillæ white or lemon-yellow, and the foot yellow.

The *form* of the body is similar to that of the other members of the same genus. The frontal veil is semilunar in shape with a notch in the middle line, it has from fifteen to twenty shallow indentations; the *tentacles* are large, and present no peculiarities of form; the sheath of the *rhinophoria* is short and cylindrical, with plain margin; the club-shaped extremity of the rhinophoria is provided with about ten leaf-like appendages, the apex of the hindermost of these is very strong. The *dorsal surface* is almost even, with scattered minute tubercles; on the but slightly prominent margin of the back are from twenty-five to thirty variously sized small branchial tufts which present the usual structure. The sides of the body are rather high and quite smooth. The genital and anal papillæ and the renal pore occupy their usual positions. The furrow on the anterior margin of the foot is very distinct; the tail is only present as a rudiment.

The intestines are not visible through the body-wall.

The *central nervous system* has no peculiarities; the pedal ganglia are somewhat larger than the cerebral. The long principal commissure gives off a nervus genitalis. The buccal ganglia are large and oval in form; the gastro-œsophageal are very small.

The *otolithic vesicles* are situated at the anterior margin of the pleural ganglia. Each contains about one hundred otoconia of the usual kind.

The *bulbus pharyngeus* is large, and measures from 7·5–10 mm. in length, 5–6 mm. in height, and 6–7·25 in breadth. The labial disk, as well as the posterior part of the mouth-tube, is of a dark blackish-brown colour. The *mandibles* are of a greenish-yellow hue, the masticatory edge coal black, and the adjacent part brownish-black. The form of the mandibles (Pl. XI. fig. 16) as usual. The masticatory edge appears even under the lens; nevertheless it is provided with several, mostly eight or nine, series of short, thick, strong plates and teeth, which gradually increase in size towards the anterior margin, the foremost measuring as much as ·12 mm. (fig. 17). The free margin of the wings behind the mandibles is blackish. The *tongue* is of the usual form, and blackish in colour along the median line of the under surface; the radula varies from mahogany-brown to black, and contains twenty-four and twenty-seven series of teeth in each of the two individuals examined respectively; posteriorly there are seven and thirteen developed, and three not fully developed series, the total number of series being thus thirty-four and forty-three in each of the two specimens. In the hindermost series there were thirty-five teeth in one specimen and forty-two in the other, and the number of teeth further back within the sheath of the radula increases to thirty-seven and forty-five. The breadth of the most anterior median tooth is about ·22 mm., of the hindermost about ·28 mm.; the height of

the lateral teeth ·25 mm., of the outermost ones ·16 mm. The colour of the teeth within the radula sheath of a bright yellow, those anterior being darker in hue. The median plates (fig. 18, *a*) of the usual shape, as also the clumsy first lateral plate (fig. 18, *b*,*b*); the rest of the teeth are somewhat low and curved towards the point (Pl. XII. figs. 2–5), most ones are more slender in form (fig. 6).

The *salivary glands* are whitish in colour, and measure from 10–14 mm. in length by 1·5–2·25 mm. in breadth. The efferent ducts are rather long.—The *stomach* and œsophagus were as usual, measuring together 13 or 14 mm. in length by 5–7 mm. in breadth; the inner surface was thrown into a series of longitudinal folds; the aperture of the main bile duct was large. The *intestine* leaves the large visceral mass at about the middle point; its length is about 16 or 17 mm., its diameter 3 or 3·5 mm., the inner surface covered with strong longitudinal folds. In both specimens the buccal cavity, œsophagus, and stomach were filled with a hard brown mass, consisting of the funnel-shaped remains of an Alcyonarian (up to a height of 5·5 mm.);[1] the intestine was mainly filled with the elongated spicules of the same animal. The *liver* (visceral mass) was 17–18·5 mm. in length, by 7·5–10 mm. in breadth; the anterior end obliquely truncated, the posterior end rounded; its colour was a dirty brown, darker inside than outside; its cavity rather narrow.

The *pericardium* and the *heart* were as usual. The *renal syrinx* (fig. 7, *a*) 1·1–1·2 mm. in length, yellowish-white in colour, with a series of strong longitudinal folds in the inside; the duct was greyish-brown in colour, the inner surface provided with arborescent overgrowths (fig. 7, *b*).

The *hermaphrodite gland* forms a single mass, whitish in colour, and composed of a great number of lobes; it clothes the upper and posterior portion of the large visceral mass; the gonoblasts are developed in the lobes.—The *anterior genital mass* is elongated and somewhat compressed, with a length of 9–10 mm., a height of 5–6 mm., and a breadth of 3–4 mm.; the efferent ducts, moreover, project for 2·5 mm. The *ampulla* of the hermaphrodite duct forms the hinder portion of the genital mass; its colour is an opaque yellowish-white, its shape elongated, somewhat curved at either end, its length 2·2 cm., its greatest diameter 2·5 mm. The *ductus ejaculatorius* (Pl. XI. fig. 19, *aa*) is coiled up on the inside of the penis; when unrolled it measures nearly 2 cm. in length. The penis is pear-shaped and about 2 mm. long; the glans is conical in form and elongated, one half of it freely projecting (fig. 19, *d*); the seminal duct runs up to the extremity of the organ. The spermatheca (Pl. XII. fig. 8, *a*) is oval, 2·5 mm. long, and in both specimens was completely empty; it opens by a duct (fig. 8, *b*), which, at its distal end, was dilated into an ampulla (fig. 8, *c*). The *mucous gland* was of a chalk white colour; the *albuminiparous gland* yellowish, with fine windings.

[1] Beiträge z. Kenntn. d. japan. Nudibr. II., *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien.*, Bd. xxxi. 1881, pp. 248, 249.

II. *Marionia*, Vayssière.

Marionia, A. Vayssière, Sur un nouveau genre de la famille des Tritioniadés, Comptes rendus, t. lxxv., 1877, pp. 299–301.

„ A. Vayssière, Description de la Marionia Berghii, Journ. de Conchyl., sér. 3, t. xix., 1879, pp. 106–118, pl. vii.

„ R. Bergh, Beitr. zu einer Monogr. d. Gatt. Marionia, Vayss., Mittheil. d. zool. Stat. zu Neapel, Bd. iv., 1883, pp. 297–320, Taf. xxi.

Forma corporis ut in Tritoniis propriis ; limbus frontalis digitatus, digitis compositis numerosis.

Ventriculus lamellis solidis armatus.

The genus *Marionia* is readily distinguished from *Tritonia* by the form of the processes of the frontal veil, and by the armed condition of the stomach.

A number of species have been referred to this genus, many of which may possibly prove to be identical ; they are as follows :—

1. *Marionia blainvillea* (Risso).
   Marionia berghii, Vayss.
   Mediterranean.

2. *Marionia decaphylla* (Cantraine).
   Mediterranean.

3. *Marionia quadrilatera* (Schultz).
   Mediterranean.

4. *Marionia affinis*, Bergh.
   Mediterranean.

5. *Marionia tethydea* (delle Chiaje).
   Mediterranean.

6. *Marionia costæ* (Verany).
   Mediterranean.

7. *Marionia meyeri* (Verany).
   Mediterranean.

8. *Marionia acuminata* (O. G. Costa).
   Mediterranean.

9. *Marionia elegans* (Audouin, Savigny).
Red Sea.

10. *Marionia cyanobranchiata* (Rüppell und Leuckart).
Red Sea.

11. *Marionia occidentalis*, n. sp.
Western Atlantic.

Marionia occidentalis, n. sp. (Pl. XI. figs. 3–15).

* ? *Tritonia cucullata*, Couth., Gould., Expl. Exped., Moll., 1852, p. 308, pl. xxv. fig. 403, *a.-f.*

Habitat.—Western Atlantic. Off Buenos Ayres.

This species may be identical with *Tritonia cucullata* of Gould, from the shores of Rio Janeiro; but since this identity, even if it exists, will probably never be certainly proved, the name *Marionia occidentalis* may stand.

One specimen only was dredged on February 25, 1876, from a depth of 13 fathoms, in lat. 35° 2′ S., long. 55° 15′ W., in the bay of Buenos Ayres. It was well preserved in alcohol.

The total *length* of the individual was 4·3 cm., its height 9 mm. and breadth 10 mm.; the breadth of the foot 8 mm.; the length of the rhinophoria 4 mm., that of the branchiæ 4 mm. The *colour*[1] of the animal was of a bright grass green; the dorsal surface is divided by lines into a number of green polygonal areas. The clubs of the rhinophoria and the points of the branchial leaves, as well as of the finger-like processes of the frontal margin, are whitish or light yellowish-grey. The sides are of a whitish colour, which becomes greenish towards the edge of the mantle; they are covered all over with a number of round or longitudinally oval slightly prominent white spots. The circumference of the mouth and the margin of the foot are greenish, but the under surface is yellowish.

The body is somewhat slender; the crescent-shaped *frontal veil* is small and provided with about twenty finger-like processes, which resemble those of other species of the genus; the *tentacles* are spoon-shaped and not strongly developed; the club of the *rhinophoria* is provided with about ten bipinnate appendages; the terminal papilla of the rhachis of the hindermost one is very prominent. The *branchiæ* are, as in the other representatives of this genus, distributed along the margin of the dorsal surface—thirteen on each side—the posterior being much smaller than the other. That portion of the dorsal margin which lies between the branchiæ is concave. Each *branchia* consists of a stem, which is divided into four, three, and two branches, which are again divided into two and three branchlets, which terminate in bipinnate twigs. The *genital papilla*

[1] The living animal is probably green on the upper surface and reddish over the rest of the body.

occupies its usual position beneath the second interbranchial space; from it projected the conical glans penis, which attained a length of 4 mm. The *anal papilla* and the minute renal pore are situated beneath the fourth interbranchial space. The *foot* resembles that of other *Marioniæ*, the free margin projecting about 1·75 mm.; the *tail* measured about 2·25 mm. in length, and had a triangular crest 2·25 mm. in height.

The viscera are not visible through the body-walls.

The *central nervous system* is small; the cerebro-pleural ganglia (Pl. XI. fig. 3, *a,b*) are reniform in outline, and the two divisions are quite distinct, and the anterior is somewhat larger. The cerebro-pedal and pleuro-pedal connectives are very distinct; the nervus vaginæ rhinophorii, nervus olfactorius, nervus tentacularis, nervi frontales, nervi palliales, nervi musculares bulbi, nervus opticus and ganglion opticum resemble those of other *Tritoniæ*. The pedal ganglia (fig. 3, *c,c*) are rounded and short stalked, they are a little larger than the cerebral; the nervi pediaei as usual. The olfactory, buccal (fig. 3, *g*), and gastro-œsophageal ganglia (fig. 3, *hh*) are like those of other *Tritoniæ*.

The *eyes* (fig. 3, *i*) are situated as usual at the base of the rhinophorial sheath; they are oval in form, about ·22 mm. in diameter, and are provided with a large lens and black pigment. The large *otocysts* (fig. 3) are placed either behind or upon the pleuro-pedal connective; each contains about 100 otoconia, the largest of which have a diameter of ·03 mm.

The *mouth-tube* with its retractor muscles was quite typical. The *bulbus pharyngeus* measured 10 mm. in length, 6 mm. in height, and 7 mm. in breadth; it is not different from that of other species of *Marionia*; as in *Marionia quadrilatera*, the black, deeply pigmented wall of the buccal cavity was visible on the upper surface of the bulbus. The labial disk is whitish in colour. The *mandibles* (Pl. XI. fig. 4) correspond in measurement with the bulbus pharyngeus. Their colour is chitinous yellow; in shape they are closely similar to the mandibles of other species of the same genus, differing merely in being somewhat narrower, and in having a more pointed posterior extremity; the masticatory process (fig. 4, *a*) is long, the masticatory edge (figs. 5, 6) straight and armed along its whole length with three or four series of denticles, the highest of which measure about ·12 mm. The *tongue* is of the usual form; the radula, of a chitinous yellow colour, stands out in marked contrast to the rest of the organ, which is black. The radula contains forty series of teeth (counted along the outer margin); further back, beneath the tectum radulæ and within the radula-sheath, there are eight fully-developed series of teeth, one half-developed, and three delicate transparent series; the total number of series of teeth is thus fifty-two. The greatest number of teeth contained in one of the anterior series of the sheath was eighty, but nearly all the series of the tongue were incomplete. The breadth of the oldest median teeth was ·28 mm., of the newest ·39 mm.; the length of the outermost plates on the posterior portion of the radula was ·12, ·16, ·2, and ·25 mm., the longest measured as much as ·4 mm. The median teeth

(Pl. XI. fig. 7, *a*,*a*) and the first lateral tooth (fig. 7, *b*,*b*) closely resemble those of other species of *Marionia*. All the (other) lateral plates (figs. 8–11), with the exception perhaps of the outermost ones, are covered on their outer edge with fine oblique striations, and the outer margin of the recurved extremity (fig. 12) is very finely serrated; sometimes a similar striation is seen on the inside (fig. 10). The outer teeth (fig. 11) have the normal form. There were present also (Pl. XI. fig. 8) a number of irregularly formed teeth.

The *salivary glands* resemble those of other *Tritoniæ;* they are whitish in colour and measure about 7 mm. in length and 2·5 mm. in breadth; the efferent duct is about 3 mm. long.—The œsophagus is like that of other *Tritoniæ*. The *first stomach* is spherical, with a diameter of 5·5 mm.; the second short and cylindrical, with a length of about 1·5 mm. *Chitinous plates* are developed in the *second stomach*, and are visible through its walls; they are pale yellow in colour and variable in form; they were present to the number of sixty; a larger plate frequently alternated with one, two, or three smaller plates; the length of the larger plates was about 1·13 mm., and the height ·6 mm.; two of the plates were considerably larger than the rest (fig. 13). The *intestine* passes over the succenturiate liver; it is 14 mm. long by 2–1 mm. in diameter; a thick fold was developed on its inner wall, ending in a freely projecting extremity at about the end of the first half. The whole digestive tract, from the mouth to the anus, was filled with animal débris, apparently of Alcyonarians.

The *liver* is of the usual form, conical; its length is about 19 mm., and the breadth of the anterior portion about 7 mm., the colour is yellowish-white with a faint tinge of green. The *succenturiate liver* lies beneath the intestine; it is about 5 mm. broad, 3 mm. in height, and nearly 3 mm. in length; the colour is greyish-brown; the internal cavity is small, and opens by a distinct duct into the hinder portion of the first stomach.

The *renal syrinx* opens into the anterior portion of the pericardium on the right side; its shape is oval, with very strongly developed interior folds; the length is about 1·5 mm.

The *hermaphrodite gland* forms a thick whitish layer over the yellow liver; its structure was perfectly typical, in the lobes zoosperms and large oogene cells were found. The *anterior genital mass* forms an oblong somewhat compressed body of about 9 mm. in length, 6 mm. in height, and 5·5 mm. in breadth; the position of the different portions of the genital mass was normal. The *ampulla* of the hermaphrodite duct is largely developed and whitish in colour; the *ductus ejaculatorius* (fig. 14, *d*) is very long, and forms a coil at the base of the penis, which when unrolled has a length of 2·5 cm. The *penis* (fig. 14, *e*, 15) is about 4 mm. long, and projects freely; it is elongated and conical in form, and has the usual structure. The *spermatheca* (fig. 14, *a*) is spherical, of about 4 mm. diameter; the efferent duct (fig. 14, *b*) is about double the length of the sac itself; the inferior half is dilated into a vagina (fig. 14, *c*); the mucous gland is whitish, the albuminiparous gland yellowish in colour.

II. Order.—NUDIBRANCHIATA HOLOHEPATICA.

This Order comprises the Doridide and Doriopsidæ, nearly all of which, with the exception of one deep-sea form (*Bathydoris*), are littoral in habit.

Family Doridid.

Sub-family I. Doridide Phanerobranchiatæ.

Ohola, n. gen.

Forma corporis fere ut in *Polyceris*, sed limbo frontali simplici, recto. Branchia pauci-(3-) foliata. Appendices dorsales colosseæ, simplices. Tentacula vix ulla. Rhinophoria vaginata, clavo perfoliato.

Lamellæ mandibulares fere ut in *Polyceris* propriis. Radula fere ut in *Polyceris* propriis, rhachide nuda, pleuris dentibus majoribus hamatis duobus, et dentibus externis paucis (2).

This new genus shows a general agreement with the true *Polycera* in its outward form. The *frontal margin*, however, has no prolongations, the *branchia* has only a few (3) simple tufts. On the dorsal margin on each side are two huge papillæ. The *rhinophoria* are provided with a very marked sheath; the club is strongly perfoliated; there are no *tentacles*.—The strong *mandibular plates* are like those of *Polycera* proper (*Polycera quadrilineata*), so also the *tongue*, which has two powerful lateral teeth, and only a few (2) outer teeth. The armature of the penis is like that of *Polycera*.

Ohola differs, however, from *Polycera* in having a strong sheath for the rhinophoria, in its even frontal margin, the absence of tentacles, and the huge development of the dorsal papillæ, which give the animal a most remarkable appearance. There is but one species known at present.

Ohola pacifica, n. sp. (Pl. IX. figs. 9–22).

Habitat.—Pacific (Arafura Sea).

Of this form I found a single individual, somewhat altered in shape by pressure, in company with *Bornella excepta* and *Janolus australis;* it had been preserved in picro-sulphuric acid; the specimen was captured in the Arafura Sea in September 1874.

The specimen (fig. 9) was 13 mm. long, 5 mm. broad, and 3·5 mm. high; the length of the anterior papillæ was 4 mm., of the posterior pair 8–9 mm., the length of the

rhinophoria was about 1·5 mm., of the branchial tufts 2 mm.; the breadth of the base of the foot 5·4 mm., the length of the tail 5 mm.

The *colour* of the animal was whitish, the gill yellowish, the tip of the papillæ black, the clubs of the rhinophoria greenish-grey with a white tip. At the neck (fig. 9) the bulbus pharyngeus and central nervous system with the black eyes were visible from the outside, and the liver behind the branchia and the hermaphrodite gland at the base of the first right papilla.

The *form* of the body is remarkable on account of the huge dorsal papillæ (fig. 9, *a*,*a*), and is short and clumsy. The *mouth* is rounded, a little funnel-shaped; there is no trace of any *tentacles*. Above the quite even frontal margin, at the neck are the circular apertures for the rhinophoria, out of which project the tips of these; the club of the latter has a great number (50 ?) of the usual thin leaves. The *branchia* stands about on the middle of the back, and is formed of three tufts; the right hand one gives off a strong branch at its base. Behind the branchia is the low *anal papilla*, in front to the right of which is the renal aperture. From the lateral margin of the back, which is hardly to be distinguished from the sides of the body, arises in the neighbourhood of the rhinophoria, the *first smaller pair of papillæ*; further back, behind the region of the branchia, the *second pair* (fig. 9, *a*,*a*), which is twice as large as the first pair. The papillæ are cylindrical or club-shaped, somewhat narrower below, rounded above, and slightly excavated at the apex. The *tail* is strong. The *sides of the body* are high, less so anteriorly and posteriorly; the wrinkled genital opening lies behind the first papilla on the right. The *foot* is rather broad and strong; in front its angles are small; the lateral brim projects about ·8 mm. from the sides of the body; posteriorly it ends in a rounded apex.

The *central nervous system* is not much flattened; the cerebro-pleural ganglia are reniform, the two divisions being very distinct; the pleural are thicker and somewhat larger than the cerebral. The pedal ganglia are roundish and a little smaller than the pleural. The three commissures are separate, not quite as long as the diameter of the pedal ganglia. The proximal olfactory ganglion nearly sessile and bulb-shaped; the distal one much smaller, roundish, and situated at the base of the rhinophorial club. A small ganglion opticum gives rise to the optic nerve, which is nearly double as long as the diameter of the eye. The buccal ganglia are a little larger than the proximal olfactory ganglia, round in shape and united by a commissure about equal in length to the diameter of the ganglia. A strong nerve could be followed throughout the whole length of the papillæ as far as the apex.

The *eyes* are large, and provided with abundant black pigment and a yellow lens. The *otocysts* are rather smaller than the eyes, and contain a small number of otoconia. The leaves of the club of the rhinophoria are delicate, and contain no spicules. The *skin* and interstitial connective tissue are without spicules, and contain an enormous mass of variously sized unicellular glands. On the apex of the dorsal papillæ the skin was thicker,

containing a number of large vesicular glands; in the neighbourhood of the apex were a number of special glandular structures (fig. 21), which appeared to resemble renal tissue; the condition, however, of this part of the body hindered further research.

The wide *mouth-tube* measures about 1·5 mm. long. The stout *bulbus pharyngeus* is about 2 mm. long, 1·75 mm. broad, and 1·5 mm. high; the radula sheath projects a little beneath at the hinder end; the form of the bulbus is nearly as usual, but peculiarly flattened on the upper surface; within the oval labial disk were the dark brown edges of the *mandibular plates*, the upper transverse pieces of which were visible through the walls of the bulbus. The mandibular plates (fig. 10) resemble those of *Polycera quadrilineata*, they are strong and hard, and yellowish in colour; the length of the longitudinal piece ·75 mm., of the transverse piece ·1 mm.; they consist of two parts inclined to each other at nearly a right angle (fig. 10). The *longitudinal piece* (fig. 10, *b*) mainly lies naked in the labial disk, and is sickle-shaped; the anterior surface is rather convex, marked with several oblique lines, reaching above as far as the junction; the outer margin is strongly projecting, separated by a deep furrow from the transverse piece; the hinder surface is a little concave, reaching as far as the junction, and passes into the transverse piece by means of a rounded crest; the inner margin is a little convex above; the under end brought to a point. The *transverse piece* (fig. 10, *a*) of the mandible is scarcely longer but (especially behind) broader than the longitudinal; it lies nearly horizontally, but sloping downwards slightly in its anterior portion; the upper side is a little convex, and traversed by an oblique longitudinal crest; the under side is rather concave; from the (fig. 10) inner portion of the upper margin, quite separate from the hinder surface, a flat piece takes its rise, which extends backwards, and becomes attached to the inner margin of the longitudinal piece; there is a deep furrow between this flat extension and the longitudinal piece, and also between it and the transverse piece. The structure of the *bulbus pharyngeus* is as in *Polycera*.[1] The *tongue* is as usual, broad and strong; the chestnut-coloured radula is visible through the upper wall of the bulbus, and contains eight rows of teeth; further back there are three developed and one undeveloped rows, the total number is therefore twelve. The first row of the tongue is reduced to the inner lateral teeth, but the following series is complete; the lateral teeth of this and the following rows were somewhat worn out. The teeth had a dirty yellowish or brownish-yellow colour. The length of the outermost tooth on the hinder part of the tongue was about ·1 mm., of the next plate ·14 mm.; the innermost lateral plate measured ·2, and the large one as much as ·3 mm. The rhachis (fig. 11, *a*) is rather broad, and traversed by wavy folds. The two lateral teeth, rather similar in shape, have a flattened basal portion, and a powerful smooth hooked extremity; from the outer margin of the body arises a strong wing-shaped process. The inner lateral plate is smooth, and less

[1] Bergh, Beitr. zu einer Monogr. d. Polyceraden, I. *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien*, 1879, Bd. xxix. pp. 606, 607.

in size (figs. 11, *b*, 12, 13, 14, *a*), with a shorter basal portion and a shorter broader hook. The outer lateral tooth is larger, and has a much stronger hook, with an obliquely truncated posterior extremity (figs. 11, *c*, 14, *b*, 15, *a*,*a*). Of the two outer teeth one (figs. 11, *d*, 15, *b*, 16, *a*, 17), the inner one, was considerably larger and broader than the other; it measured about ·04 mm. high; on the inside it was higher, and slanted outwards. The outer tooth was shorter, narrower, and lower, coming to a point behind; on the inside it was lower (figs. 11, *e*, 16).

The white *salivary glands* were long, but thin; the *efferent ducts* short.

The *œsophagus* is rather narrow, about half as long again as the bulbus, and opens into the *stomach*, which is nearly spherical, and measures about 3 mm. in diameter; its colour is grey, and it lies partly in the wide cleft of the liver. The *gut* is thin, and breaks through the left side of the liver in a deep furrow; it forms a large arch in front of the liver and extends backwards (fig. 9, 22, *a*) to the anal papilla, measuring about 8 mm. long, and its interior shows fine longitudinal folds. The contents of the stomach were Siphonophores, Hydroids, Foraminifera, and some of the stomachal teeth of the animal itself.

The *liver* is anteriorly truncated, somewhat cup-shaped, on account of the broad and deep cleft for the reception of the stomach, and measures 4·5 mm. in breadth and length, and 3·5 mm. in height; the posterior extremity is rounded; the colour is brownish; it is smooth, with the exception of a few deep furrows in front; its cavity is rather wide. The pear-shaped *gall bladder* is large, appearing as a large facet behind the stomach on the upper surface of the liver, about 2 mm. high.

The *heart* has the usual structure. The small yellowish-white flattened, oval *blood-gland* lies behind the central nervous system.—The *urethra* (fig. 22, *b*) has a length of fully 2·5 mm., and is attached to the rectum; with the urethra is connected, by a lateral tube, the *renal syrinx* (fig. 22, *d*).

The *hermaphrodite gland* appeared, so far as could be made out, not to cover the liver, but was found underneath in front of the liver as a long, strong, yellowish mass; the lobules contained no developed sexual products.—The *anterior genital mass* was but slightly developed, about 3 mm. long. The prostate was small; the *vas deferens* was not long, nor very thin, forming a single loop, and then passing into the *penis*. This latter organ in the individual, which I examined, was retracted. The armature (fig. 18) of the anterior part of the vas deferens was ·5 mm. in length. The spines (figs. 18–20) were arranged in some ten or twelve longitudinal series, in each series nearly twenty to twenty-five; their colour was a clear yellow; the hindermost were about ·007–·009 mm. high, the most anterior ·04 mm.; the hindermost were tubercle-shaped (fig. 20), and then gradually increasing in height; the anterior ones were generally straight, but also curved and of irregular form (fig. 18). The *spermatheca* was spherical, the *spermatocyst* sac-like. The *mucous gland* was whitish in colour.

Euplocamus, Philippi.

Euplocamus, Philippi, Enum. Mollusc. Siciliæ, i., 1836, p. 103.
„ Alder, Note on Euplocamus, Triopa, and Idalia, Ann. and Mag. Nat. Hist., ser. vol. xv., 1845, p. 262.
„ Gray, Guide, Dist. Moll. Brit. Mus., part i., 1857, p. 215.
„ Alder and Hancock, Monogr. Brit. Nudibr. Moll., pt. vii., 1855, p. xix.
„ R. Bergh, Beitr. zu einer Monogr. d. Polyceraden. I., Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxix., 1880, pp. 623–639.[1]

Corpus vix depressum. Tentacula plicæformia, apice auriculatim soluta; rhinophoria retractilia, clavo perfoliato. Branchia 3 (5) foliata. Margo frontalis sicut margo dorsalis appendicibus arborescentibus ornati.

Orificium oris utrinque lamella triangulari, e baculis minutis dense confertis composita armatum. Lingua rhachide nuda, pleuris dentibus lateralibus majoribus 2–3 et serie dentium externorum breviori (5–6) vel longiori (18–35) armatis.

Prostata magna spermatothecam et spermatocystam amplectens.

The genus *Euplocamus* was established by Philippi[2] in 1836, but in 1844 the name was withdrawn by him, under the erroneous impression that it was synonymous with *Idalia*, a genus founded by Leuckart in 1828. Although Alder, in 1845, showed that *Euplocamus* was really distinct from *Idalia*,[3] the mistake of Philippi was repeated in the handbooks of Philippi, Woodward, and others, as well as throughout the compilatory works of Gray,[4] Hermannsen,[5] and others, and in the memoir of Lovèn.[6] The differences between *Euplocamus* and *Idalia* were clearly formulated by Alder and Hancock in 1855, and by Gray in 1857, but nevertheless they have subsequently been frequently confounded,[7] or *Euplocamus* has been united with *Triopa*.[8] This controversy was finally settled by a memoir written by myself in 1880, in which the external characters of *Euplocamus*, as well as its anatomy, are treated of.

Euplocamus has the frontal margin only slightly prominent but strong, somewhat branched frontal appendages, of the same nature as the lateral appendages of the back. The *tentacles* are mere folds of the skin, free at one edge like the tip of an ear; the retractile *rhinophoria* have the club perfoliated. The branchia has from three to five tripinnate

[1] This generic name has already been applied to a Lepidopteron by Latreille (1809), and later to a bird by Temminck (1838). If it is therefore to be changed, I would suggest *Kaloplocamus*.

[2] Philippi, Enum. Mollusc. Siciliæ, ii., 1844, p. 76.

[3] Alder, Note on Euplocamus, Triopa, and Idalia, *Ann. and Mag. Nat. Hist.*, ser. vol. xv., 1845, p. 262.

[4] Gray, List, etc., *Proc. Zool. Soc.*, 1847, p. 165.—Gray, Figures of Mollusc. Anim., vol. iv., 1850, p. 105.

[5] Hermannsen, Index gen. Malacozoor. prim., i., 1846, p. 435.

[6] Lovèn, Index Moll., 1846, p. 5.

[7] Chenu, Man. de Malacol., t. i., 1859, p. 406.—Verany, Catal. des Moll. de, &c., Nice. *Journ. de Conchyl.*, t. iv., 1853, p. 386.

[8] Abraham, Revision of Anthobranchiate Nudibranchiate Mollusca, *Proc. Zool. Soc.*, 1877, p. 230. Hancock, however, had long ago pointed out the great differences between *Euplocamus* and *Triopa* (Alder and Hancock, Monogr. Brit. Nudibr. Moll., pl. vi., 1854, Gen. *Triopa*, Note).

tufts. The oral orifice has a strong triangular *labial plate* on each side, composed of high upright densely set rods. The *tongue* has (always ?) a naked rhachis, three large lateral teeth on each side, and a shorter or longer series of external teeth. The large *prostate* embraces the seminal vesicles.

Euplocamus is transitional between *Polycera* and *Triopa* on the one hand and *Plocamophorus* on the other, but presents closer affinities to the latter genus. Only a few species[1] are known, all natives of the warmer seas. Nothing is known of their habits and development.

The following is a list of the known species :—

1. *Euploçamus croceus*, Philippi.
Mediterranean.

2. *Euplocamus japonicus*, Bergh.
Japanese Sea.

3. *Euplocamus pacificus*, n. sp.
Pacific.

Euplocamus pacificus, n. sp. (Pl. III. fig. 30 ; Pl. IV. figs. 7–24).

Habitat.—Pacific Ocean, neighbourhood of Kermadec Islands.

Dentes linguales laterales duo, dentes externi pauci (5–6).

A single individual was dredged from a depth of 630 fathoms on July 14, 1874, between the Kermadec Islands, and was well preserved in alcohol. Its length was 27 mm., height 10·5 mm., and breadth 9·5 mm. ; the length of the rhinophoria 5 mm., two-thirds at least of which formed the club ; the length of the branchial tufts 4·6 mm., of the dorsal appendages 5 mm.; the breadth of the sole of the foot was about 5·2 mm., the length of the tail 7·5 mm. The *colour* was whitish over the whole body, except the branchia, which had a tinge of yellow, and the sulphur yellow margins of the leaves of the rhinophoria.

The *form* of the body is somewhat quadrangular ; the back rather convex. The height is greatest in front of the branchia, behind which it gradually decreases ; the sides of the body high and convex, and gradually decreasing from the region of the branchia backwards ; the foot is narrower than the back. The *frontal* margin does not project far (about 1·2 mm.), it is slightly emarginate in the middle line ; on either side are from

[1] Several species hitherto described belong really to the genera *Idalia*, *Polycera*, and *Triopa*.

eight to ten frontal appendages, whose length is somewhat greater than the breadth of the frontal margin itself; the appendages are more or less arborescent, somewhat flattened and smoother on the under surface, they are irregularly bi- and tripinnate, the branches being mainly developed upon the margins of the stem; the terminal branches are elongated and conical, sometimes strongly drawn out; between the branches are frequently minute cones or branchlets; a number of small, simple, or tufted processes are often found between the main appendages of the frontal margin; close to the outer and hindermost of these is the round opening of the rhinophoria on either side with a slightly prominent unevenly notched margin.[1] The *rhinophoria* are strong; the shorter and more delicate stalk[2] is sharply marked off from the club, which was somewhat bent backwards; the rounded pyramidal club has about fifty broad thinnish leaves on either side, the short strong terminal papilla has an oval contour. The *head* is rather large; on either side is a *tentacle*, which has the appearance of a fold of the skin with a free lobe-like inferior extremity; its length is 2·5 mm., and its breadth at the base 1 mm.; on the anterior side of the free extremity there is, as in *Euplocamus japonicus*, an indistinct furrow. The mouth-tube in this specimen was retracted, and the short cylindrical labial disk (yellow in colour on account of the strongly developed cuticle) projected 2·5 mm.; at the rounded truncated anterior extremity was the narrow perpendicular *oral aperture*. From the hinder portion of the frontal margin runs on either side, along the edge of the back, a low fold as far as the root of the tail, in which it vanishes. From this dorsal margin arise on either side five *dorsal appendages*, of which the two hindermost are closest together; the rest being separated by nearly equal intervals, and placed each almost exactly opposite its fellow. The first was situated behind the region of the rhinophorion, the last at the junction of the back and tail. The dorsal margin between these appendages was somewhat undulating, and here and there prolonged into very small appendages.[3] These appendages exactly resembled those of the frontal margin, but had their branchlets more extended.[4] The hindermost appendage on either side was about double the size of the others, and formed of two appendages fused at the bases, of which the anterior was lower than the posterior. The *branchia* is formed of three broad and flattened tripinnate branches, the middle one being rather larger than the other two; from the base of the lateral branch, especially the left hand one, was given off outwards a strong branch; this indicates five branchial tufts as a number which is probably present in other individuals. The low truncated cylindrical anal papilla has a length of about ·6 mm., and entirely resembles that of other species of *Euplocamus*;[5] the margin of the opening is undulating; masses of food were projecting from the wide anal opening, and could easily be drawn out. At the base of the right

[1] Bergh, *loc. cit.*, p. 626, Taf. xi. fig. 9, *a*.
[2] *Loc. cit.*, fig. 9, *b*.
[3] *Loc. cit.*, Taf. xii. fig. 7.
[4] *Loc. cit.*, Taf. xi. fig. 11.
[5] *Loc. cit.*, Taf. xii. fig. 9.

hand gill tuft is the fine *renal pore*.[1] The dorsal surface itself was beset here and there with small points, which were also present upon the sides of the body, and especially upon the tail, on which they formed here and there villous processes. The *tail* has a dorsal keel. The genital papilla is large and lies beneath the right dorsal appendage; it has[2] two openings (præputium, vulva), surrounded by a common margin, and beneath the slit-like orifice of the duct of the mucous gland. The *foot* is of the same breadth throughout its whole extent, and only narrows behind at the tail, which gradually comes to a point; it stands out about 1·4 mm. from either side of the body; its anterior margin is straight, with projecting angles and a deepish furrow; the upper lip is split in the middle line.

The intestines were indistinctly visible on the back and sides of the body from the outside. The cavity of the body extended as far back as the region behind the last dorsal appendage. The peritoneum was colourless.

The *central nervous system* (Pl. IV. figs. 7, 8) is not much flattened; it is enclosed as usual in a (not very tight) capsule. The *cerebro-pleural* ganglia (figs. 7, *ab*, 8, *ab*) lie obliquely, their length exceeds their breadth, and the anterior is broader than the posterior portion; they are somewhat kidney-shaped, and the two parts of which they are made up are distinct from each other; the cerebral portion has a rounded contour, and is somewhat larger than the pleural. The *pedal* ganglia are oval (figs. 7, *c*, 8, *c*), and about as large as the cerebro-pleural. The nerve cells range up to ·25 mm. in diameter. At the base of the eye is a small sessile *optic* ganglion (fig. 7). The cerebral ganglia give off a *nervus tentacularis*, two *nervi labiofrontales*, and several *nervi retractorum bulbi*. The pleural ganglia give off a *nervus visceralis*, two *nervi palliales*, and the right a *nervus genitalis* in addition. The pedal ganglia give off two *nervi pediaei breves* and a single *nervus pediaeus longus*.[3] The *common commissure* (figs. 7, *d*, 8, *d*) is wide and strong; in the sheath it is composed of three separate commissures. The proximal *olfactory* ganglion (fig. 7, *ee*) is sessile and bulb-shaped, and about as large as the buccal; the distal ganglia are about the same size, oval in contour, and lie at the base of the rhinophoria; the *nervus olfactorius* is directed upwards, and pursues a winding course. The *buccal* ganglia (fig. 7, *f*) are round and planoconvex, and united with each other directly; they lie upon the strong band-like anterior part of the musculus transversus bulbi posterior superior; from each ganglion a strong *nervus lingualis posterior* takes its origin, from the outside of the *nervus lingualis superior*, which bifurcates immediately from the upper surface the *nervus œsophagealis*. A *gastro-œsophageal* ganglion I was unable to find.[4] At the base of the penis there was a round flattish ganglion of about ·25 mm. greatest diameter. I observed here and there portions of a *sympathetic system*, with minute ganglia.

[1] Bergh, *loc. cit.*, Taf. xii. fig. 9.
[2] *Loc. cit.*, Taf. xiii. fig. 2.
[3] *Loc. cit.*, p. 628.
[4] *Loc. cit.*, p. 629.

The *eyes* (figs. 7, 8) have an extreme diameter of about ·18 mm., and are sessile upon the optic ganglia; their pigment is black, and the lens pale yellow. The *otocysts* are nearly as large as the eyes, and lie close to them; they contain about 100 pale yellowish, round and oval otoconia, measuring up to ·02 mm. (fig. 9). The leaves of the rhinophorial club contain only a few hardened cells. A few generally rod-shaped spicules were present in the axis of the rhinophoria. In the skin were a great number of strong and hard spicules of very variable size and shape; their length reached about ·65–·8 mm., and their diameter ·02 mm.; the spicules were rod-like (Pl. III. fig. 30), regularly or irregularly cross-shaped, bifurcate at one or both ends (fig. 30), or six rayed (Pl. IV. fig. 10); the surface of the spicules was smooth or thickly covered (fig. 10) with fine points and tubercles. There were also large spicules in the dorsal and frontal appendages, but apparently none in the branchial leaves. In the interstitial connective tissue there were scattered here and there hardened cells, but no larger spicules.

The *mouth tube* appeared to be as usual. The *bulbus pharyngeus* is strong, compressed from before backwards, 4·2 mm. long by 3·5 broad and 3·5 high; the thick, short radula-sheath projects downwards about 1 mm. and is 8 mm. broad; the first half of the bulbus consisting of the labial disk, which resembles very much the collum uteri of the female; a little behind the middle of the bulbus is situated the usual circular furrow, somewhat emarginate above, in which is fastened the strong *retractor bulbi*. The muscular apparatus of the bulbus appeared to be as usual.[1] The *labial disk*, as above mentioned, is large and strong; on the anterior margin is an oval perpendicular groove in which lies the perpendicular mouth slit, within which is visible the yellowish-brown margin of the labial plates. The labial disk is covered by a strong yellow cuticle, which is radially striate in the neighbourhood of the groove already mentioned; near the internal margin it is darker, and appears under the microscope to be rather destroyed. On the inner side of the anterior part of the buccal cavity, reaching to the margin of the mouth-slit, there is on each side the strong chestnut-coloured[2] (brownish-black in the anterior inferior margin) labial plate (figs. 11, 12). Both plates are separated above and below by a furrow; the anterior cutting edge of the left is sharper, and comes beyond the right hand one. The plates have a rounded triangular contour, the greatest diameter is 1·9 mm.; towards the posterior margin they become thinner, elsewhere they are about ·6 mm. thick (fig. 12); the posterior thinner margin is nearly perpendicular, inclined a little obliquely backwards; the thicker under portion runs horizontally forwards, it has a broad longitudinal furrow; the convex anterior margin is the thickest, it thins off a little towards the upper angle; on the right plate (fig. 12) the margin falls off obliquely (fig. 12), and is slightly excavated along its length; on the left the inner half of the margin is strongly flattened and slopes behind; the corners are rounded (fig. 11), the posterior inferior especially; the attached outer surface is arched from above downwards, and a

[1] Bergh, *loc. cit.*, p. 630.

[2] Colour of the fruit of *Æsculus hippocastanum*.

little excavated in the direction of the long axis; the free inner side is perfectly smooth under the microscope, and is somewhat concave in height and length, especially in the hinder half, from which the anterior half stands off like a special facette. More minute investigation showed the plates to be of a dense and finely striated structure, in which, however, there was no trace of any rods (as in *Euplocamus croceus* and *japonicus*[1]). The *tongue* is very large, somewhat flattened, covered as far as the radula with a thick, tough, whitish cuticle; the cleft is deep, rather wide, and covered at its sides by the yellowish radula, and closed behind by the keel-shaped projecting lingula. The structure of the organ appeared to agree with that of *Euplocamus croceus*.[2] The rhachis of the radula was divided into areas by furrows (fig. 13), and with strong arches formed of closely-pressed furrows lying behind each other, and separated by intervals. At the point of the tongue there were several similar arches and furrows, which appeared to indicate that several rows of teeth had formerly been present, but were now rubbed off. The *radula* had ten or eleven rows of teeth, but further back, within the radula-sheath, there were but three fully developed and two undeveloped series; the total number was thus about sixteen The first two or three rows were incomplete, and the large teeth upon them were evidently worn. Each row had two large lateral (fig. 13, *ab*), and, at any rate in the young series, six external teeth (fig. 13, *cc*). The *lateral plates* were rather like each other, the innermost (figs. 13, *aa*, 14, *a*, 15, *a*) somewhat smaller than the outer ones (figs. 13, *bb*, 14, *b*, 15, *bb*). The basal portion of these lateral plates is flattened and obliquely truncate behind; from the outer margin arises obliquely a strong compressed crest, rounded above; in front the basal portion is continued into the incurved hook, the apex of which is rather flat (figs. 13, 14). The *outer row of teeth* joins the hinder half of the base of the second lateral plate (fig. 13, *cc*). There were five of these external teeth in the middle of the tongue and six elsewhere. The innermost of these (figs. 16, 18, *aa*) has just a trace of the terminal hook, and is larger than the others, which otherwise resemble each other; they are longish, a little depressed, but hardly perceptibly broader than high; the under surface is narrower than the upper, which slopes outwards, the inner margin being more bulged forward (figs 16–18). The teeth were all yellowish, the large side plates rather darker in their thicker portions. The length of the inner lateral plates (on the root of the tongue) was about ·5 mm., their height about ·3 mm.; the outer lateral plates usually ·6 mm. in length by ·4 mm. in height; the length of the innermost outer tooth was ·28 mm. in length and ·08 in height; the succeeding one measured ·22 mm. in length, the third ·2, the fourth ·18, the fifth ·16, and the sixth ·14 mm. The tissue of the radula-pulp contained a number of large odontogenous cells behind the younger series of teeth.

The *salivary glands* were smaller, and did not extend so far back as in *Euplocamus croceus*;[3] they were yellowish-white in colour; the efferent ducts rather short.

[1] Bergh, *loc. cit.*, Taf. xi. fig. 12; Taf. xii. fig. 14. [2] *Loc. cit.*, p. 630. [3] *Cf.* Bergh, *loc. cit.*, p. 632.

The *œsophagus* was short, with fine longitudinal folds on the inner surface. The *stomach* large, 8 mm. long, about 4 mm. in diameter, lying on the upper side of the posterior end of the bulbus pharyngeus and of the anterior genital mass, the hinder portion covered by the angle of the gut. The inside of the stomach had longitudinal folds; into the hinder portion opens the short wide bile duct. The *intestine* beside this latter perforates the liver and runs in a fine groove on its surface, forms an angle, and is then directed towards the foot, and runs finally to the anal papilla along a superficial groove in the liver. The inside of the intestine has fine longitudinal folds. The length of the intestine was 2·5 cm., the diameter from 1·5–2·5 mm. The contents of the whole alimentary tract were a soft mass, which appeared to consist mainly of Bryozoa (reminding one of *Crisidia*, Milne-Edwards).

The *liver* is nearly heart-shaped, with the broad end directed anteriorly; two facets are formed upon it by the anterior genital mass, and from about the middle beneath and somewhat to the right, arises the main bile duct; the hinder portion is rounded; the circumference is also rounded, the under side only a little flattened. On the upper side is the shallow furrow for the first portion of the intestine; on the right side, anteriorly, is the obliquely-directed furrow of the hinder portion of the intestine, running upwards, and ending in the neighbourhood of its appearance on the surface of the liver. The colour of the liver substance is dirty yellowish; the upper surface, owing to the presence of the hermaphrodite gland, is clearer. The length of the organ is 1 cm., the breadth and height (of the anterior portion) about 9 mm. Its cavity is wide; on the walls are fine, generally perpendicular, folds; beneath the main bile duct, and on the right, is a broad round bile opening; on the lower wall are several smaller openings. The contents of the liver were the same as those of the rest of the alimentary tract. The *gall-bladder* was on the right side of the pylorus, dirty yellow in colour, about 4 mm. high.

The *pericardium* was situated at the anterior end of the liver, resting on the gut. The ventricle of the *heart* measured 2·5 mm. in length; the atrium very large. The *blood gland* lies behind the central nervous system, and somewhat obliquely upon the stomach; it is strongly flattened, and has a greatest diameter of about 4 mm.; it is lobulate at the margin and whitish in colour.

The *renal syrinx* is yellowish-white, about 1 mm. long, and pear-shaped. The *urinary chamber* and the *kidney* appeared to resemble those of the typical species.[1]

The *hermaphrodite gland* clothes the liver all round with a thinnish layer, about ·3 mm. thick, being absent only at the anterior part of the hinder visceral mass in the region of the bile duct; it is yellowish-white in colour, and has the usual structure, the small yellowish ovarian follicles covering the greyish testicular follicles; the gonoblasts are ripe. The hermaphrodite duct takes its origin above the main bile duct; it is thickish, and rapidly dilates into the ampulla.—The whitish *anterior genital mass* is

[1] Bergh, *loc. cit.*, p. 634.

planoconvex; the hinder surface has two facets, one on the left, which is the larger, and another on the right; the anterior surface is convex; the upper margin rather flattened, the other sharp; the length of the mass from before backwards reached 4·5 mm. by 8·5 mm. in breadth and 7·5 mm. in height; the chief efferent ducts project 2 mm. Along the upper margin runs the *vas deferens*, forming several loops and then running straight; on the posterior side the vaginal duct is directed upwards from the spermatheca; on the under side, between the mucous gland and the prostate, is the chocolate-grey ampulla. The largest portion of the genital mass is formed by the prostate, showing a number of cells and holes glimmering through. The sausage-shaped, somewhat curved chocolate-grey ampulla, is about 5 mm. long by 1·5 mm. in diameter. The female branch of the hermaphrodite duct opens in or in the neighbourhood of the albuminiparous gland;[1] and the uterine duct of the spermatheca (fig. 23, *d*) also communicates with it. The *spermatheca* (fig. 23, *a*), with the exception of the region of the ducts, is quite covered by the prostate; it is pear-shaped, and 5·5 mm. in length, yellowish in colour, and filled with semen and detritus. Its main external duct, the *vaginal duct* (fig. 23, *b*), is thinner, and has a rather straight course; it then increases to three or four times its diameter, and ascends, bending outwards, to the genital papilla (fig. 23*c*); the whole length of the duct is about 8 mm., of which nearly one-half belongs to the vagina, which is rather thick-walled with longitudinal folds within. The other, the *uterine duct* (fig. 23, *dd*), rises near the last, but is thinner, and forms a descending loop; when stretched to its full length it measures about 10 mm.; at about the junction of its middle and posterior third is the *spermatocyst*. This last (fig. 23, *e*) is short and pear-shaped, 1·4 mm. long; whitish in colour and filled with semen, it lies beneath the vas deferens, and upon the upper margin of the anterior genital mass; its thin duct is about as long again as the bladder. The *male branch*,[2] which takes its origin from the hermaphrodite duct, is short, and immediately enters the *prostate*, which is very large, and together with the included spermatheca occupies about four-fifths of the entire anterior genital mass; it is whitish, with an even upper surface; the prostatic layer reaches a thickness of 1–1·8 mm. on the posterior side of the spermatheca. From the upper side of the left hand end a small, somewhat flattened, thin-walled prolongation (fig. 24, *a*), about 4 mm. long, issues; it is the *vas deferens*; it then narrows and forms a loop, and runs in a straight course to the genital papilla; this last muscular whitish-coloured part of the vas deferens is about 1 cm. in length (fig. 24, *b*); at the end it is wider, and forms the præputium *penis*, which has a length of about 1 mm., and at the base of which is the round aperture of the retracted glans. That portion of the vas deferens which is provided with hooks is quite 7 mm. long; the hooks appeared to be arranged in twenty to twenty-five irregular longitudinal rows (forming quincunces ?), the number of rows behind appeared to be hardly greater than in front. The *hooks* (figs. 20–22) are of a yellowish colour; their size is variable, the greatest length being ·13 mm.

[1] Bergh, *loc. cit.*, Taf. xiii. fig. 13.

[2] *Loc. cit.*, Taf. xiii. fig. 13, *i*.

(fig. 20); behind they are rather smaller, hardly exceeding ·1 mm. in length (fig. 21). Their base of attachment is of a rounded triangular form, from which the spine arises more or less obliquely (fig. 22); the spinal portion is awl-shaped, and is more usually curved than straight; occasionally abnormal forms arise (fig. 22), by the division of one or the fusion of the neighbouring spines. The axis of the basal portion of the larger spines is finely granulate, sometimes it is granulate through a larger extent (fig. 22). The white *mucous gland* with its fine windings forms the right portion of the anterior genital mass; on the hind portion of its left side is the clear yolk-yellowish *albuminiparous gland;* the *duct* of the mucous gland has the usual strong longitudinal fold.

This species differs in the armature of the tongue from the two other species which the genus contains; these have three large lateral teeth, while this species has only two; it has also a smaller number of outer teeth (five or six) than the others (eighteen or thirty-five). There are also some essential differences in the details of the generative system.

Sub-family 2. Dorididæ Cryptobranchiatæ.

Chromodoris, Alder and Hancock.

Chromodoris, Alder and Hancock, Monogr. Brit. Nudibr. Moll., pt. vii., 1855, p. xvii.
„ Bergh, Neue Nacktschnecken der Südsee, III., Journ. d. Mus. Godeffroy, Heft viii., 1875, pp. 72–82; Heft xiv., 1878, pp. 1–50.
„ idem, Untersuch. d. Chromodoris elegans u. villafranca, Malacozool. Blätter, Bd. xxv., 1878, pp. 1–36.
„ idem, Neue Chromodoriden, Malacozool Blätter N.F., Bd. i., 1879, pp. 87–116.
„ idem, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft xi., 1877, pp. 464–494; Supplementheft i., 1880, pp. 14–27; Heft ii., 1881, pp. 81–85.
„ idem, Beitr. zur Kenntn. d. japan. Nudibr. II.; Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxxi., 1881, pp. 219–222.
„ H. v. Jhering, Beitr. zur Kenntn. d. Nudibr. d. Mittelmeeres, Malacozool. Blätter, N.F., Bd. ii., 1880, pp. 1–56; Taf. i.–iii.

Forma corporis fere ut in Goniodoridibus, sed colores hilares, sæpe magnifici, ut plurimum striati vel maculati. Branchia (retractilis) foliis simpliciter pinnatis.

Armatura labialis e hamulis minutis confertis composita. Radula rhachide nuda, pleuris multidentatis. Dentes hamati, primi utroque latere hami denticulati, reliqui externo solum; extimi humiles, apice denticulati.—Penis inermis.

The genus *Chromodoris* was first established, though on insufficient grounds, in 1854, by Alder and Hancock.[1] Ten years later the same authors[2] gave a more accurate

[1] Alder and Hancock, Monogr. Brit. Nudibr. Moll., pt. vi., 1854, Fam. 1, pl. xvii., Gen. 2 (*Goniodoris*, F.).

[2] Alder and Hancock, Notice of a collection of Nudibranchiate Mollusca made in India, *Trans. Zool. Soc. Lond.*, vol. v., part 3, 1864, p. 123.

and sufficient description of its characters. The genus *Goniobranchus* of Pease,[1] I am inclined, from an examination of his typical species, to consider identical with *Chromodoris*. The genera *Glossodoris*, *Actinodoris*, and *Pterodoris* of Ehrenberg, established in 1831, differ only in unessential and inconstant characters of the branchia, and hence must be incorporated with *Chromodoris*.[2] The genus *Doriprismatica* of d'Orbigny, established in 1834, must also be regarded as merely a variety of *Chromodoris*.

I have of late years examined a great number of species of this genus.

Chromodoris, in form and outward characters, resembles rather closely the very different *Goniodoris*, and on this account the two genera have been frequently confused; but the *colour*, even, is quite different.

The tentacles are small and conical; the retractile rhinophoria have a perfoliated club. The edge of the mantle is prominent, and usually forms a frontal and caudal veil. The retractile *branchia* is formed of simply pinnate leaves. The *armature of the labial disk* is strong, and composed of a number of densely-set small hooks, bifid at the tip. The radula contains no rhachidian teeth, but there are frequently thickenings which take their place. The lateral teeth are numerous and hook-shaped; the first lateral tooth is denticulate on both sides, the rest denticulate only upon the external margin; the outward teeth are smaller, and denticulate at the extremity. The penis is unarmed.

The genus *Chromodoris* is readily distinguished by its external characters from *Casella*; from *Aphelodoris* it differs by the armed condition of the labial disk, and by the characters of the branchia. As far as is known at present, the genus is confined to the tropics, or at least the warmer seas, and is the most abundant genus of the Family Dorididæ. Practically nothing is known concerning its habits and development.[3]

The following is a list of the known species:—

1. *Chromodoris zebrina*, Alder and Hancock.
   Indian Ocean.

2. *Chromodoris elisabethina*, Bergh.
   ? Doris quadricolor, Leuckart.
   ? Actinodoris sponsa, Ehrenberg.
   Philippine Sea.

3. *Chromodoris annæ*, Bergh.
   Philippine Sea.

[1] *Amer. Journ. of Conch.*, vol. ii., 1866, p. 204.

[2] Bergh, Kritische Untersuch. d. Ehrenberg'schen Doriden, *Jahrb. d. deutsch. malakozool. Gesellsch.*, Bd. iv., 1877, pp. 52–58.

[3] Pease, *Amer. Journ. of Conch.*, vol. vii., 1871, pp. 15, 19.

4. *Chromodoris striatella*, Bergh.
Philippine Sea.

5. *Chromodoris gloriosa*, Bergh.
? Doris dorsalis, Gould.
Pacific Ocean.

6. *Chromodoris scurra*, Bergh.
Pacific Ocean.

7. *Chromodoris histrio*, Bergh.
Pacific Ocean.

8. *Chromodoris luxuriosa*, Bergh.
Pacific Ocean.

9. *Chromodoris lemniscata* (Quoy et Gaimard).
Indian Ocean (Isle de France).

10. *Chromodoris lineata* (Souleyet).
Pacific Ocean.

11. *Chromodoris magnifica* (Quoy et Gaimard).
Pacific Ocean (New Guinea).

12. *Chromodoris whitei* (Adams and Reeve).
Chinese Sea.

13. *Chromodoris trilineata* (Adams and Reeve).
Chinese Sea.

14. *Chromodoris marenzelleri*, Bergh.
Japanese Sea.

15. *Chromodoris bainardi* (Kelaart).
Japanese Sea.

16. *Chromodoris villafranca* (Risso).
Doris pulcherrima, Cantraine.
Doris tenera, O. G. Costa.
Doris scacchi, delle Chiaje.
? Doris pasinii, Verany.
Mediterranean.

17. *Chromodoris cantrainii*, Bergh.

Goniodoris elegans, Cantraine.
Doris picta, Schultz.
Doris schultziana, delle Chiaje.
Doris villafranca, delle Chiaje.
Doris nardii, Verany.
Doris calcaræ, Verany.
? *Doris infucata*, Rüppell und Leuckart.
? *Doris lutescens*, delle Chiaje (Verany).
? *Doris valenciennesii*, Cantraine.
? *Doris marmorata*, Savigny.

Mediterranean.

18. *Chromodoris cærulea* (Risso).

Doris tricolor, Cantraine.

Mediterranean.

19. *Chromodoris gracilis* (delle Chiaje).

Doris gracilis, Rapp.

Mediterranean.

20. *Chromodoris messinensis*, v. Jhering.

? *Doris villæ*, Verany.

Mediterranean.

21. *Chromodoris albescens* (Schultz).

? *Doris pirainii*, Verany.

Mediterranean.

22. *Chromodoris luteo-rosea* (Rapp).

var. *Chromodoris jheringi*, Bergh.
? *Doris parthenopeia*, delle Chiaje.

Mediterranean.

23. *Chromodoris elegantula* (Philippi).

Mediterranean.

24. *Chromodoris krohnii* (Verany).

Mediterranean.

25. *Chromodoris purpurea* (Risso).

? *Doris pallens*, Rapp.

Mediterranean.

26. *Chromodoris orsini*, Verany.
? Goniodoris cælestis, Deshayes.
Mediterranean.

27. *Chromodoris mörchii*, Bergh.
Goniodoris picturata, Mörch.
West Indies.

28. *Chromodoris decora* (Pease).
Pacific Ocean.

29. *Chromodoris marginata* (Pease).
Pacific Ocean.

30. *Chromodoris lineolata* (van Hasselt).
Indian Ocean, Java.

31. *Chromodoris alba* (van Hasselt).
Indian Ocean.

32. *Chromodoris dorsalis* (Gould).
Pacific Ocean.

33. *Chromodoris runcinata*, Bergh.
Philippine Sea, Pacific.

34. *Chromodoris semperi*, Bergh.
Philippine Sea.

35. *Chromodoris paupera*, Bergh.
Philippine Sea.

36. *Chromodoris verrucosa* (Crosse).
Pacific Ocean.

37. *Chromodoris erinaceus* (Crosse).
Pacific Ocean.

38. *Chromodoris virginea*, Bergh.
Philippine Sea.

39. *Chromodoris obsoleta* (Rüppell und Leuckart).
Red Sea.

40. *Chromodoris tinctoria* (Rüppell und Leuckart).
Red Sea.

41. *Chromodoris pulchella* (Rüppell und Leuckart).
Red Sea.

42. *Chromodoris pallida* (Rüppell und Leuckart).
Glossodoris xantholeuca, Ehrenberg.
Red Sea.

43. *Chromodoris variegata*, Pease.
Pacific Ocean (Tahiti).

44. *Chromodoris maculosa*, Pease.
Pacific Ocean (Tahiti).

45. *Chromodoris tryoni* (Garrett).
Pacific Ocean.

46. *Chromodoris rufo-maculata*, Pease.
Pacific Ocean (Huaheine Islands).

47. *Chromodoris pustulans*, Bergh.
Philippine Sea.

48. *Chromodoris simplex*, Pease.
Pacific Ocean (Maiao Islands).

49 *Chromodoris albo-maculata*, Pease.
Pacific.

50 *Chromodoris albo-notata*, Bergh.
Pacific.

51. *Chromodoris inornata*, Pease.
Pacific.

52. *Chromodoris lentiginosa*, Pease.
Pacific (Huaheine Islands).

53. *Chromodoris varians*, Pease.
Pacific.

54. *Chromodoris pulchra*, Pease.
Pacific.

55. *Chromodoris vibrata*, Pease.
Pacific.

56. *Chromodoris propinquata*, Pease.
Pacific.

57. *Chromodoris picta*, Pease.
Pacific.

58. *Chromodoris bennetti* (Angas).
Pacific.

59. *Chromodoris loringi* (Angas).
Pacific.

60. *Chromodoris mariei* (Angas).
Pacific (New Caledonia).

61. *Chromodoris splendida* (Angas).
Pacific.

62. *Chromodoris daphne* (Angas).
Pacific.

63. *Chromodoris festiva* (Angas).
Pacific.

64. *Chromodoris albo-pustulosa*, Pease.
Pacific.

65. *Chromodoris crossei* (Angas). n. gen. ?
Pacific.

66. *Chromodoris pusilla*, Bergh.
Pacific.

67. *Chromodoris punctulifera*, Bergh.
Pacific.

68. *Chromodoris montrouzieri* (Crosse).
Pacific.

69. *Chromodoris elegans* (Quoy et Gaimard).
Pacific.

70. *Chromodoris citrina*, Bergh.
Pacific.

71. *Chromodoris verrieri* (Crosse).
Pacific (New Caledonia).

72. *Chromodoris lamberti* (Crosse).
Pacific (New Caledonia).

73. *Chromodoris petiti* (Crosse).
Pacific (New Caledonia).

74. *Chromodoris souverbiei* (Crosse).
Pacific (New Caledonia).

75. *Chromodoris smaragdina* (Gould).
Pacific.

76. *Chromodoris picturata* (Ehrenberg).
Red Sea.

77. *Chromodoris erythræa* (Ehrenberg).
Pacific.

78. *Chromodoris pallescens*, Bergh.
Pacific.

79. *Chromodoris camoena*, Bergh.
Pacific.

80. *Chromodoris thalassopora*, Bergh.
Pacific.

81. *Chromodoris lapinigensis*, Bergh.
Pacific.

82. *Chromodoris pantharella*, Bergh.
Pacific.

83. *Chromodoris dalli*, Bergh.
East Pacific.

84. *Chromodoris californiensis*, Bergh.
East Pacific.

85. *Chromodoris reticulata* (Pease).
Pacific.

86. *Chromodoris godeffroyana* (Pease).
Pacific.

87. *Chromodoris glauca*, Bergh.
Pacific.

88. *Chromodoris gonatophora*, Bergh.
West Indies.

89. *Chromodoris rudolphi*, Bergh.
Pacific (Island of Tonga).

90. *Chromodoris maccarthyi* (Kelaart).
Indian Ocean.

91. *Chromodoris pretiosa* (Kelaart).
Indian Ocean.

92. *Chromodoris fidelis* (Kelaart).
Indian Ocean.

93. *Chromodoris cardinalis*, Bergh.
Pacific (Tonga).

94. *Chromodoris peasei*, Bergh.
Doriprismatica lineata, Pease.
Pacific (Sandwich Islands).

95. *Chromodoris mollita*, Abraham.
Locality unknown.

Chromodoris striatella, Bergh (Pl. III. figs. 26–29; Pl. IV. figs. 1–4).

Chromodoris striatella, Bgh., Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.) Heft vi., 1874, Tab. xxxiii. fig. 4; Heft xi., 1877, p. 474–478, Tab. li. figs. 24–25.

„ Idem, Neue Nacktschnecken d. Südsee. Journ. Mus. Godeffr. Heft viii. 1875, p. 73; Heft xiv., 1878, p. 5.

† *Doris lineolata*, van Hasselt, Extrait d'une lettre du Dr. J. C. van Hasselt au Prof. van Swinderen sur les Mollusques de Java, Bull. d. Sci. Nat. et de Zool., t. iii., 1824, p. 258.

Color fundamentalis brunnescens, sed ubique fere lineolis flavescentibus depulsus, pallii margine citrino; rhinophoria et branchia rubra punctulis nigris.

Habitat.—Philippine Sea (Burias, Masinloc), Pacific (Port Denison, Torres Strait).

Of this species three examples were taken on September 8, 1874, in Torres Strait, Station 186, lat. 10° 30′ S., long. 142° 18′ E.; depth, 8 fathoms; bottom, coral sand.

They were well preserved in alcohol. The length reached to between 2 and 3 cm., the breadth 11 or 13 mm., and the height 7 to 8·5 mm.; the breadth of the foot 3·5–5 mm., the breadth of the margin of the mantle 2–2·5 mm.; the height of the rhinophoria 2·5 mm., of the branchia 3·5 mm.

The *colour* of the animal, preserved in spirit, is black or velvet black; on the dorsal surface of the mantle edge are a number of yellowish-white lines running parallel with it, variable in size and in number; in front the number is somewhat smaller than behind, where it is mostly from about six to eight. The dorsal surface proper is traversed by a number of similar lines, which are more or less continuous, and branch and anastomose; the margins of the mantle and of the foot are yellowish-white in colour; the under surface of the mantle edge, and the sides of the body as far as the margin of the foot, are covered with similar but stronger (8–14) lines, a variable number of which are prolonged onwards over the tail. The margin of the rhinophorial aperture is whitish; the stem of the rhinophoria blackish-grey, the club yellowish, with white points on the edges of its leaves. The margin of the branchial cavity is surrounded by radially arranged white lines; the branchial leaves at the root and along the chief rhachis are entirely of a blackish-grey colour, but the leaves themselves are yellowish, sprinkled with whitish-yellow points. The anal papilla (and its neighbourhood) are spotted with black, whitish at the end; the sole of the foot is yellowish, the tentacles white, the neighbourhood of the mouth yellowish-grey. The genital papilla is whitish.

The *form* of the body is as usual. The club of the rhinophoria has from thirty to twenty-five leaves. The diameter of the roundish branchial cleft about 4 mm.; the branchia is rolled into a spiral at both ends; each half is formed of nine leaves, of which the five hindermost are smaller and simply feathered, the others are larger and are divided

above into 2–4 branches, each of which is simply feathered. The anal papilla between the rolled-up ends of the branchia is about as high as the branchial leaves, cylindrical in form, and a little thicker above, and with a round-indented opening. On the right hand side is the wide renal pore.

The largest specimen was carefully dissected. The pericardium was of a chocolate-brown colour, as also the part of the peritoneum covering the blood glands.

The *central nervous system* was difficult to investigate, as it lay in a strong sheath of connective tissue. The cerebro-pleural ganglia were reniform, with arched surfaces; the two divisions very distinct, the hindermost larger than the foremost. The pedal ganglia lying outside the pleural are a trifle smaller than these, and plano-convex in form. The common commissure is narrow, hardly longer than the diameter of the central nervous system; the three commissures of which it is composed are clearly distinguishable, and of these the hindermost is partly free from the other. The proximal olfactory ganglia are sessile and bulb-shaped, the distal somewhat smaller and pear-shaped. The buccal ganglia (Pl. IV. fig. 1, *aa*) are a little larger than the proximal olfactory ganglia and plano-convex, they are united by a short commissure; the gastro-œsophageal ganglia are short-stalked and small, they are situated on the outer side of the nerve, they are not more than one-tenth of the size of the buccal ganglia (fig. 1, *bb*).

The *eyes* are short-stalked, the pigment is black, the lens yellow. The *otocysts* are rather smaller than the eyes, with about 200 otoconia of the usual kind. The walls of the cavity of the stalk and of the club of the *rhinophoria* are covered with greyish-black pigment.

The *mouth tube* is strong, 3·5 mm. long, whitish-yellow in colour; the inferior and median pairs of retractor muscles are very long; its interior is as usual. The *bulbus pharyngeus* is strong, 3·5 mm. long, by about 3 mm. in height, and 3·5 mm. in breadth; the radula-sheath projects about ·5 mm. below. The arched labial disk surrounds the perpendicular mouth slit, which is provided with a continuous dark yellowish coloured armature, which, especially below, but also above, passes over a portion of the labial disk. This *prehensile ring* is interrupted neither above nor below; above it is a trifle narrower, being below about 1·2 mm. broad. The ring, as usual, is formed of densely set straight or somewhat curved yellow rods, about ·06 mm. in height, which are bifurcate (Pl. III. fig. 26) at their upper extremities. The *tongue* is broad, with a deep cleft, which is covered up over its margins by the clear yellow-coloured radula; in this last are forty-two *series of teeth*, further back thirty-two developed and four not fully developed series; the total number thus is seventy-eight. The first eleven rows are more or less incomplete; on the middle of the tongue are about fifty-eight teeth on each side, at its base sixty, and the number increased passing backwards to sixty-two or sixty-three. In the very narrow rhachis, corresponding to the hinder end of the body of the innermost teeth (fig. 27, *a*), there are small, quite colourless thickenings of the cuticle, cleft at their hinder extremities.

The teeth are clear yellow coloured. The length of the innermost of them measures about ·04 mm., increasing gradually to ·17 mm., then decreasing towards the exterior, the four outermost measuring ·09–·08, ·075 or ·05 mm. The innermost teeth have from one to two denticulations on the inner side of the hook, and about four upon the outer side (fig. 27, *bb*). Throughout the row of teeth the length of the hook gradually increased, but decreased at the outermost portion; the length of the basal portion, on the contrary, only increased very little, and decreased again in the outermost portion of the row. All the teeth were denticulated along the outer margin almost as far as the end of the hook (Pl. III, fig. 29; Pl. IV. fig. 2); the smooth bent termination had quite disappeared in the outermost one to three teeth (figs. 28, 29). The number of denticulations was usually from seven to nine, sometimes eleven to twelve; on the innermost five to eight teeth they were fewer in number, mostly four or five; also in the outermost five or six were commonly seen; there were, however, several of the outermost teeth with only eleven or twelve of the finest denticulations (fig. 29, *a*). There were also several quite smooth teeth.

The *salivary glands* are of considerable extent, and whitish in colour, about 12 mm. long by ·3–·5 mm. in thickness; they pass backwards from the bulbus beneath the anterior genital mass, and are attached to the liver; they run side by side in the middle line, and frequently wind round each other. The efferent ducts are short.

The *œsophagus* is about 2·5 mm. broad by 8 mm. in length, on the inner surface are strong longitudinal folds; it opens into the cavity of the liver by a wide circular opening, which here appears to act as a *stomach;* it was filled with the débris of food. Behind the middle of the upper left hand wall is the round opening into the *intestine,* which in its anterior part is about 9·5 mm. long; it increases in width posteriorly up to 2·5 mm., and then narrows to about 2 mm.; the posterior half has a length of about 15 mm., by a diameter of 1·2 mm. Its interior has numerous fine longitudinal folds. The contents of the intestinal tract were indistinguishable animal remains.

The *liver* is 9 mm. long by 7·5 mm. in breadth, and 6·5 mm. in height; the anterior portion is broad, obliquely cut off behind and on the right, with a deep median cleft for the œsophagus; the somewhat narrower hinder end is rounded; on the left of the anterior half of the upper side is a broad furrow for that portion of the intestine which runs forward; on the right hand is a narrower furrow for the portion directed backwards; the colour of the (upper part of the liver) is brownish-grey; its interior yellowish-white. The *gall-bladder* is large and sac-like, 2·5 mm. in diameter; lying in front of the base of the intestine and beneath it, opening by a short duct.

The *pericardium* is large. The chamber of the heart (Pl. IV. fig. 3, *b*) about 2 mm. long. The *blood glands* cover the central nervous system; they are whitish, very flattened, irregularly-oval, and lobulate on the margin; the anterior is 3 mm. thick, the hinder 4 mm. The urinary chamber (fig. 3) forms a deep cleft, with a round lumen, with numerous thicker or thinner ridges and partition walls at the sides, which are visible through the thin upper

wall, to which is fixed the aorta. The chamber commences at the hinder end of the liver, and extends a little in front of its anterior boundary; it is covered on either side by the masses of renal tissue (fig. 3, *dd*), which do not exceed 1·5–2 mm. in breadth, except in the anterior and posterior extremities, and are of a yellowish colour within, changing to white upon the outside; they are traversed from within outwards by prolongations of the clefts lying on the side walls of the urinary chamber; the cavities appear more or less distinctly through its walls, and are round or somewhat angular in form. Behind is the simple opening of the duct of the renal syrinx (fig. 3), just beside the ascent of the vena hepatica magna to the branchia, and of the intestine to the anal papilla, and the continuation of the urinary chamber ascends as a urethra to the renal groove. The *renal syrinx* (fig. 3) is bulb-shaped, of ·75 mm. greatest diameter; the folds of the interior can easily be seen from the outside; the ciliated cells are as usual. The duct of the renal syrinx is about 1·5 mm. long, opening into the chamber; in the interior are the usual villi and papillary outgrowths.

The sexual products in the *hermaphrodite gland* were hardly developed. Thus the *anterior genital mass* was not large, 4·5 mm. long, 1·5 mm. broad, and 3·5 mm. high; the main efferent ducts, moreover, projected 1 mm. The whole genital mass is yellowish in colour. The ampulla of the hermaphrodite duct lies in many coils, when unrolled it is about 1 cm. long by ·4 mm. diameter. The long vas deferens is considerably thinner than the ampulla, and covers it for the most part with numerous windings; its length, when unrolled, is about 1·4 cm.; below it is much thinner and passes into the penis, which is thicker, and reaches a length of 2 mm. The last-mentioned organ (præputium) is provided with a small papilla at the bottom of its cavity. The spherical *spermatheca* (fig. 4, *a*) is about 1·5 mm. in diameter; the vaginal duct (fig. 4, *b*) is about a half longer than the receptaculum seminis, below it is somewhat enlarged, and forms the vagina; the uterine duct (fig. 4, *c*) is much thinner; close by its origin is the short-stalked sausage-shaped *spermatocyst* (fig. 4, *d*), which has a length about equal to that of the spermatheca. Both receptacula seminis were filled with detritus. The *mucous gland* is heart-shaped, somewhat compressed; on its outside, at the posterior end, a part of the yolk-yellow albuminiparous gland was laid bare. The duct of the mucous gland is provided with the usual fold.

Chromodoris runcinata, Bergh (Pl. VI. figs. 1–4).

> *Chromodoris runcinata*, Bergh, Malacolog. Untersuch., *loc. cit.*, Heft xi., 1877, pp. 479–481, Taf. li. figs. 32–33, Taf. liii. figs. 5–12.

Habitat.—Pacific Ocean (Port Jackson).

A single specimen was dredged in company with *Rizzolia australis* at Port Jackson, on the 17th of April 1874, from a depth of 2 to 10 fathoms.

It was very much hardened, and measured 14 mm. long by 8 in breadth and 6 in height. The *colour* was, as usual, bluish or bluish-grey, covered with quite small white spots on the back and sides, and numerous larger bluish-black spots; upon the mantle edge were some of these larger still, and mostly arranged in a row, occasionally alternating with rather larger white ones; the margin of the foot was similar in this respect to the mantle edge; the branchia and rhinophoria were bluish-green; the tentacles and sole of the foot yellowish-grey.

The shape of the body as usual. The tentacles were retracted and inverted. The rhinophoria had each about thirty leaves. The edge of the mantle stands out about 2 mm. The caudal veil is somewhat wider. At the anterior portion of the *lateral margins* are found the usual small *conical bodies* which are also present on the hinder margin in the region of the branchia, but are stronger. The branchia has about twelve leaves, forming a circle, which are like those previously mentioned. The sides of the body and the foot I have already described.

The cerebro-pleural *ganglia* are thick, the pedal rather more flattened; the three commissures within the common sheath are quite distinguishable. The inferior olfactory ganglia are quite sessile and bulb-shaped; the upper are smaller and spherical. The buccal ganglia are a trifle larger than the inferior olfactory ganglia, round in shape, and directly united to each other. The gastro-œsophageal ganglia in this specimen were spherical, and hardly one-tenth of the size of the preceding pair; they are developed on the side of the nerve. The eyes and otocysts I have already described. The cavity of the rhinophoria was of a bluish-green colour, and contrasted with the white nerves.

The *mouth tube*, both inside and outside, was of a bluish-green, especially in the anterior region. The *bulbus pharyngeus* was 2·5 mm. long, and of a yellowish-white colour. The *labial disk* was broad, and greenish-yellow in colour, forming a ring which was only broken in the middle line, and formed of the usual elements (Pl. VI. fig. 1). The *tongue* was short and broad; its clear yellowish-green radula contained thirty series of teeth; behind twenty-eight developed and four undeveloped series; the total was therefore sixty-two. In the twentieth series of the tongue there were from ninety-four to ninety-six teeth on either side.[1] On the narrow rhachis, as in many other species of *Chromodoris*, were small colourless bifid thickenings, which might easily be altogether passed over. The *teeth* (fig. 3) are yellowish in colour; the hook is cleft at its extremity in almost all the series; on the inner margin of the hook of the innermost tooth is a strong denticle; in the outermost teeth (fig. 2) the bifurcation of the extremity is less conspicuous, and the outer margin of the hook irregularly denticulate and the denticles larger in size; in the other teeth there were often seen a few small denticles or tubercles.

The *salivary glands* are flattened and ribband-shaped, generally crenate at the

[1] In the earlier specimens investigated by me there were fifty-four to fifty-eight series, and about seventy-two teeth in each series.

margins, white in colour, broader (·75 mm.) in front than behind, and about 1 cm. long; the hinder ends of the glands beneath the bulbus are twisted round each other.

The *œsophagus* is thin, about 7 mm. long, entering in the middle of the larger facet of the posterior visceral mass, a little to the right. The cavity of the liver, as in the last species, performs the function of a stomach; it is small in extent. The *intestine* breaks through the middle of the liver, a little to the left; its loop lies anteriorly upon the anterior genital mass; posteriorly it runs in a deep groove on the right hand surface of the liver; in the middle of the anteriorly-directed portion of the intestine its width is greater (1·5 mm.), elsewhere it is only half as broad; its length when uncoiled was 1·5 cm. The digestive tract was empty.

The *liver* is 8 mm. long by 6 in breadth and 5·5 mm. in height; the anterior two-thirds of the right side hollowed out into a facet for the anterior genital mass; the hinder end is short and cylindrical; its proper brownish-grey colour is merely visible on the lower and right hand surface; elsewhere it is covered by the dirty yellow hermaphrodite gland. The small pear-shaped *gall-bladder* lies to the left, on the upper surface of the liver, close to the origin of the gut.

The faintly green *pericardium* and the *heart* were as usual. The green *blood gland* is 2 mm. in length, 1 mm. in breadth, and lies in front of and upon the anterior genital mass.—The whitish-yellow *renal syrinx* is small.

The *hermaphrodite gland* is thick, and yellowish in colour; it presents the usual structure; the lobules contain larger oogenous cells and spermatozoa.—The *anterior genital mass* is 5·5 mm. long by 3·5 mm. in height and 3 mm. in breadth; the efferent ducts are bluish-green, and project about 2·5 mm. The yellowish-white ampulla has a very slightly undulatory course; its length when straightened out is about 4 mm. The *spermatheca* (fig. 4, *a*) is spherical, 2·5 mm. in diameter, yellowish-white, it was full of semen; the vaginal efferent duct (fig. 4, *b*), together with the wider greenish-blue vagina (fig. 4, *c*), about one-half longer than the receptaculum; the uterine duct (fig. 4, *d*) is much longer and thinner. The pear-shaped *spermatocyst* (fig. 4, *e*) is very small, and sessile on the origin of the vaginal duct.[1] The *vas deferens* is long (about three times as long as the penis) and thin, whitish in colour, and passes into the conical greenish-blue coloured *penis*, which is about 4 mm. long by 2 mm. in width. At the base of the cavity of the præputium is a small perforated papilla, the glans. The *mucous gland* is white, the *albuminiparous gland* olive-brownish yellow; the duct greenish-blue outside as well as inside.

[1] The spermatocyst is quite as small in *Chromodoris semperi*. *Loc. cit.*, Taf. lv. figs. 6*b*, 7*b*.

Ceratosoma, Adams and Reeve.

Ceratosoma, A. Adams, Voyage of the "Samarang," Mollusca, 1848, p. 67.
" Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft x., 1876, pp. 391-410; Supplementheft i., 1880, pp. 28-31.

Corpus subcompressum, postice gradatim altius; nothaeum postice trilobatum, lobi laterales breviores et rotundati, posterior linguiformis; rhinophoria retractilia, clavo perfoliato; tentacula brevia; podarium sat angustum, cauda elongata.

Armatura labialis fortior, e hamulis minutissimis formata. Radula rhachide nuda, pleuris multidentatis; dentes hamati.—Penis inermis.

This genus was established by (Gray[1]) Adams and Reeve, in 1848; the definition given, however, was only superficial and entirely useless.[2] Alder and Hancock[3] corrected several of the mistakes made by these last-mentioned authors. The next contribution to the literature of the genus was a small memoir published by myself in 1876.

Ceratosoma is at once distinguishable by its peculiar form. The head is rather flat, with a short frontal margin prominent at the edges; the club of the retractile rhinophoria is provided with the usual leaves. The tentacles, as those of *Chromodoris*, can be quasi-invaginated. The body is higher behind than in front; on either side of the hindermost portion of the flattened dorsal surface is a rounded lobe, behind the back ends in a tongue-shaped process; in front of this is the circular opening for the retractile branchia. The foot is narrow and small, but the tail strong and long. The armature of the labial disk rather strong and composed of a number of closely-set minute hooks. The radula has a bare rhachis, numerous hook-shaped lateral teeth on either side. The penis is unarmed.

The genus is apparently confined to the tropics, and lives, according to Adams, crawling upon the surface of Madrepores.

Only a few species are properly known, but a number of new forms have been published by Fischer and by Abraham.[4]

[1] Alder and Hancock, Woodward, and other authors regard Gray as having the priority. The name *Ceratosoma* is to be found in vol. iv. of his Figures of Molluscous Animals (pp. 13, 42, 105: "back produced behind"), which appeared in 1850. The Malacological part of the Voyage of the "Samarang" bears on its title page the date 1848, and in this volume the genus *Ceratosoma* is described and marked "nov. gen."; according to the chief title, the Voyage of the "Samarang" did not appear until 1850. The question of priority, therefore, is difficult to settle. Perhaps Adams's drawing actually passed through the hands of Gray (*cf. Journ. des Museum Godeffroy*, Heft vi., 1874, p. 95, *Bornella*), or possibly the latter formed the genus on the species *Doris trilobata*, figured by him in 1842.

[2] The English authors mention the rhinophoria as not being retractile, and their description of dorsal processes is rather confused, *cf.* Woodward, Manual of the Mollusca, vol. ii., 1854, p. 192.

[3] Alder and Hancock, Monogr. Brit. Nudibr. Moll., pt. vii., 1855, App. xix.

[4] MM. Crosse and Fischer, like Mr. Abraham, have been recently studying the Nudibranchiata. The former authors have increased the genus by one new species, but they regard *Ceratosoma* as closely allied ("très voisin") to *Thecacera*, *Polycera*, *Aegirus*, &c. (!), and are unable to distinguish *Goniodoris* from *Chromodoris*, and *Doriopsis* from *Doris*.

The following is a list of the species :—

1. *Ceratosoma cornigerum* (Adams), Bergh.
   Indian Ocean, Philippine Sea.

2. *Ceratosoma gracillimum*, Semper.
   Philippine Sea.

3. *Ceratosoma trilobatum*, Gray.
   Red Sea.

4. *Ceratosoma polyomma*, Bergh.
   Pacific Ocean (Pelew Islands).

5. *Ceratosoma caledonicum*, Fischer.
   Pacific (New Caledonia).

6. *Ceratosoma brevicaudatum*, Abraham.
   Pacific.

7. *Ceratosoma oblongum*, Abraham.
   Pacific (West Australia).

8. *Ceratosoma tenue*, Abraham.
   Habitat ?

Ceratosoma cornigerum (Adams), Bergh, var.? (Pl. II. figs. 14–17; Pl. III. figs. 14–20).

Ceratosoma cornigerum, A. Adams, Voyage of the "Samarang," Mollusca, 1848, p. 68, pl. xix. fig. 5.
Adams, Bergh, Malacolog. Untersuch, *loc. cit.*, Heft x., 1876, pp. 393–403, Taf. xlviii. figs. 15–27, Taf. xlix. figs. 1–5.

Habitat.—Philippine Sea (Samboangan).

One specimen of this species was dredged at Samboangan, in company with *Platydoris eurychlamys* and *Discodoris morphæa*, on February 1, 1875, from a depth of 10 fathoms. The specimen was well preserved in alcohol, and measured 4·3 cm. in length by 1 in breadth and 1·5 cm. in height; the hinder dorsal process, moreover, measured 6 mm.; the breadth of the foot 5 mm., the length of the tail 16 mm., the height of the rhinophoria 3 mm., of the branchia 3·5 mm. The *colour* was greyish-red, white speckled and covered with numerous white dots, especially on the anterior portion of the back. The stem of the rhinophoria

was reddish, the club yellowish with white dashes on the margins of its leaves, and with a white terminal papilla. The branchia is reddish-yellow, with a few scattered spots upon the branchial lamellæ.

The *form* of the body is as usual. The frontal margin is somewhat strongly developed; the dorsal margin does not stand out much, its lateral lobes in front of the branchia are rounded and but feebly developed; the *dorsal process* is conspicuous and strong, and convex on the upper surface, its lateral margins somewhat bent beneath. The holes of the rhinophoria are rounded, with an inconspicuous margin; the stem of the rhinophoria is powerful, and about the same length as the strongly developed club, which latter is provided on either side with from thirty-five to forty thin leaves. The branchial cleft, when the branchia is retracted, is of a rounded triangular form, 2·25 mm. in diameter, its smooth margin inconspicuous. The hinder end of the branchia is slightly rolled up, the gill has twelve leaves, which are frequently divided at the end into two to four twigs, themselves again branched.[1] The *anal papilla* is directed obliquely forwards, and is situated in the branchial circle enclosed by its two extremities; it is short and cylindrical in form, about 1 mm. high, truncated above, greyish in colour, with whitish stripes and points; its margin is finely crenate; at its base in front and to the right is the fine *renal aperture*. The *tentacles* are short papillæ on either side of the mouth. The *foot* is rather weak.

The intestines are not visible from the outside. The peritoneum is colourless.

The *central nervous system* I have already[2] described. The common commissure is about one-third of the transverse diameter of the central nervous system, and is evidently formed of three fused strands, of which the pleural is actually separate for some distance on the right side. The *distal olfactory* ganglia are situated at the base of the rhinophorial club, and form two bulb-shaped swellings of the nerve, lying one above the other, from which, as usual, numerous branches are given off. The short oval buccal ganglia are united by a short commissure, about equal in length to one-fourth of the longest diameter of the ganglia. The small gastro-œsophageal ganglia are short-stalked.[3]

One of the nervi optici had a quantity of black pigment, the other not. The *otocysts* are visible, with a lens, as chalk-white points; they are sessile and sack-shaped, somewhat flattened (Pl. III. fig. 14), of about ·14 mm. greatest diameter; each contains about three or four hundred round and oval otoconia, yellowish in colour, and about ·015 mm. in diameter. The leaves of the rhinophoria are almost completely devoid of the hardened cells. In the *skin* of the back and of the sides of the body there were numerous small hardened cells, but no larger ones. In the outer neurilemma of the central nervous system, especially round the cerebral ganglia, were a number of spicules, more or less calcified and roundish or longish oval in shape, reaching ·08 mm. in diameter (Pl. III. fig. 15), lying isolated or in groups. In the interstitial connective tissue of other parts of

[1] Bergh, *loc. cit.*, Taf. xlviii. fig. 15. [2] *Loc. cit.*, p. 395. [3] *Loc. cit.*, Taf. xlix. fig. 6.

the body there were only a few hardened cells, with the exception of that surrounding the main ducts of the genital apparatus, where there were a number of cells similar to, but rather larger and darker than, those found in the neurilemma.

The *mouth tube* is strong, about 5 mm. in length; its inner surface and the three retractor muscles are as usual. The *bulbus pharyngeus* is 5·5 mm. long by 5·3 in breadth and 4·5 mm. in height; the radula-sheath, moreover, projects backwards about 2 mm.; the retractor muscles as usual. The strongly arched labial disk (Pl. II. fig. 14) is covered on its inner half by the rather thick yellow *labial plate*, clothing the anterior portion of the buccal cavity to a breadth of about 1 mm. with a circular prehensile ring. The labial plate is made up of hook-shaped rods thickly adpressed at the ends, which in front (Pl. III. fig. 16) reach a height of ·04 mm. The broad, strong *tongue* has the usual deep cleft, which is clothed up over the margins by the clear yellow, somewhat feebly coloured radula. In this last were twenty-eight series of teeth (counted always at the outer margin of the radula); further back there were forty-five developed and four undeveloped series; the total number was thus seventy-seven. The first three rows of the tongue were very incomplete, and in front of them were the impressions left by two or three other series that had fallen off. On the narrow rhachis (Pl. III. fig. 17, *a*, 20, *aa*) were long, narrow, very low folds. In the fifth row of the tongue there were on either side 172 or 173 teeth, at the root of the tongue 186, and the number appeared to increase on passing back in the sheath to 200. (In another smaller specimen formerly studied by me,[1] there were 80, and in larger specimens 97–104 series of teeth; the smaller individual had 170 teeth in each series, the larger individuals as many as 239.) The teeth were of a clear yellow colour; the height of the outermost generally ·05 mm., the height of the plates increasing to ·12 mm. The innermost (Pl. III. fig. 17, *bb*) is provided with a small denticle below on the inside of the hook, and in a few of these teeth a higher magnifying power (750 diam.) showed also traces (fig. 17, *bb*) of two smaller ones; on the outer side of the same innermost plate, a little higher up, was a similar denticle (fig. 20, *bb*). In all the following ones, as far as the outermost (inclusive), this outer denticle was present (Pl. III. fig. 19), and only appeared to be absent here and there in single plates. Elsewhere the teeth showed the ordinary form; the three or four outermost ones were as usual smaller and more upright, with the denticle near the point of the thick hook (Pl. II. fig. 15, *aa*).[2]

The *salivary glands* band-like, whitish in colour, extended to the length of 15 mm.; the breadth was mostly ·8 mm., but they were narrower behind; they extend,[3] as already described, as far as the cardia. The duct was rather short, about 1 mm. in length.

The *œsophagus* is mostly about 1 cm. wide, wider still behind; it opens into the stomach, and receives behind the wide bile duct. The *stomach* is 9 mm. long by 4·5 mm. in

[1] *Loc. cit.*, p. 397

[2] The series of teeth of the specimen examined here were, as in *Ceratosoma gracillimum* (*loc. cit.*, p. 404), *nearly all* denticulated, which was *not* the case in the specimens formerly dissected by me.

[3] *Loc. cit.*, 1876, p. 399.

breadth, and is situated upon the anterior genital mass. The *gut* arises from the anterior part of the stomach, and immediately bends backwards, lying in a superficial furrow at the right margin of the liver; its length is about 2·5 cm., its diameter 2·5 mm. in front, about 1 mm. behind; in the interior were fine longitudinal folds, which could be followed as far as the anal papilla. The digestive tract contained, here and there, white soft masses of food, which consisted of indistinguishable animal remains and numerous broken teeth from the radula of the animal itself; the cavity of the liver contained a similar mass.

The *liver* is some 14 mm. long by 10 mm. in height and 7 mm. in breadth; the posterior end rounded; the anterior end oblique, inclined downwards and forwards, with a deep median furrow for the œsophagus; its colour was yellowish; the cavity wide, with large crypts. There seemed to be a pear-shaped gall-bladder, about 2·5 mm. long.

The *pericardium* is large, 8 mm. broad by 5 mm. in length; the yellowish-coloured ventricle of the heart is 1·5 mm. long. The anterior *blood gland* of roundish angular contour, of a greatest diameter of 1·2 mm.; the posterior one longish oval, 3·5 mm. long; both were very much flattened and whitish in colour. The *kidney* is made up of short club-shaped acini, in which were numerous concrementa. The *renal syrinx* is yellowish and bulb-shaped, of about ·8 mm. in diameter, of the usual structure.

The *hermaphrodite gland* is made up of numerous, mostly roundish, whitish-yellow lobules, and covers the liver everywhere as far as the origin of the bile duct; the ovarian follicles are few in number, round and pear-shaped, and surround the testicular part; the gonoblasts well developed. The thin white hermaphrodite duct takes its origin at the right side of the cardia.—The *anterior genital mass* is three-sided, the anterior surface being somewhat excavated to receive the *bulbus pharyngeus;* its height is 8·5 mm., length 6·5 mm., breadth 5·5 mm.; the main efferent ducts project 1·2 mm. The opaque yellow *ampulla* is strongly bent, and placed in a deep cleft on the hinder margin of the genital mass; when extended it measured 1 cm. long by ·4–·8 mm. broad. The very long *prostatic portion of the vas deferens* forms a whitish coil upon the upper surface of the ampulla; its diameter is about ·5 mm.; it passes into the much thinner yellowish *muscular part* (Pl. II. fig. 16, *a*), which too lies rolled into a flattened coil at the anterior margin of the genital mass; when unrolled the length of this last part is 3·3 cm.; its last part passes downwards from the anterior margin of the genital mass into a prolongation (penis) bent in the middle and directed first downwards then upwards (fig. 16, *b*), and about 8 mm. in length; this prolongation was about two or three times as thick as the vas deferens, and through it the seminal passage wound its way to the very short præputium (fig. 16, *c*). The *spermatheca* (fig. 17, *a*) is yellowish in colour, and lies behind the ampulla, quite enclosed by the mucous gland; it is spherical in shape, and has a diameter of 3·5 mm.; it was filled with semen and detritus; the vaginal (fig. 17, *b*) and uterine (fig. 17, *d*) ducts pass near each other out of the spermatheca. On the root

of the latter is situated the sessile *spermatocyst;* this organ is yellow in colour and sausage-shaped, bent in the middle; when extended it measured 7 mm. long; it was full of semen. The vaginal duct is short, about one-third of the length of the spermatheca, widening below to form the vagina (fig. 17, *c*); both portions are lined with a strong cuticle. The *mucous gland* is whitish; the more yellowish albuminiparous gland is situated on its anterior and inner side. The whitish tongue-shaped *vestibulo-vaginal* gland measures 1·5 mm. long, and is sessile.

Whether the form investigated here is merely a varietyof *Ceratosoma cornigerum*, or is a distinct species, must be left for the present undecided. The armature of the tongue, and perhaps the structure of the genital apparatus, might support the latter view.

Archidoris, Bergh.

Archidoris, Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft xiv., 1878, p. 616; Supplementheft i., 1880, pp. 33–35.
„ Bergh, On the Nudibr. Gastr. Moll. of the North Pacific Ocean (*in* Dall, Scientific Results of the Exploration of Alaska, vol. i., art v.), part 1, 1879, pp. 106–108 (162–164).

Corpus non durum, subdepressum; dorso granuloso vel tuberculoso. Tentacula brevia, crassa, sulco marginali externo. Branchia (retractilis) e foliistri- vel quadripinnatis sat paucis formata. Podarium sat latum, margine anteriore superficialiter sulcatum.

Armatura labialis nulla. Radula rhachide nuda, pleuris multidentatis; dentes hamati.—Penis inermis; vagina inermis.

When Linnæus founded the genus *Doris*, in the tenth edition of his Systema Naturæ (1758), he only referred a single species to it,—his *Doris verrucosa*.[1] This species, founded solely on the figures of Seba and Rumphius, is probably indeterminable, and the *Doris* of the tenth edition of the Systema Naturæ should, therefore, not have been retained in subsequent editions. In the twelfth edition (1767) the genus includes three other forms,—*Doris bilamellata*, *Doris lævis*, and *Doris argo*, besides *Doris verrucosa*, which still figures as the first species. One of these three should become the type of the restricted genus, but which? It is much better to do away altogether with the name *Doris* as a generic designation (especially as Linnæus also used it in another sense for the animal of various shell-bearing molluscs), and with this view I have formed the genus *Archidoris*.

This generic group, which is congeneric with the first of the sections established by Alder and Hancock in their systematic prospectus,[2] is rather distinctly marked. The

[1] Bergh, Malacolog. Untersuch., *loc. cit.*, Heft x., 1876, p. 388.
[2] Monogr. of Brit. Nudibr. Moll., part vii., p. xvi., 1855.

consistency of the animal is not hard, the *form* is plump and slightly depressed; the *back* more or less granular or tuberculate, the *openings for the rhinophores* simple; the *tentacles* short, thick folds at the sides of the small head, with an external furrow; the retractile gill composed of a few tripinnate or quadripinnate leaves; the foot broad, with a furrow on the anterior margin. The *labial disk* merely clothed by a simple, thick cuticle. The *radula* with naked rhachis; the pleuræ with numerous hook-shaped plates. The large ventricle free. *Penis* and *vagina* both unarmed.

The *Archidorides* approach the *Staurodorides* in their general form and external features, but still more closely in their internal structure, though the latter are still distinguished by their numerous and simply pinnate branchial leaves, and by the development of protecting tubercles on the margin of the rhinophore-holes and of the branchial cavity.[1] The *Homoiodorides* perhaps stand in still closer proximity to the *Archidorides*, though they differ specially from the latter in a peculiar armature of the vagina.[2]

Only a few species of the group are as yet known:—

1. *Archidoris tuberculata* (Cuvier).
   North Atlantic, Mediterranean.

2. *Archidoris flammea* (Alder and Hancock).
   North Atlantic.

3. *Archidoris montereyensis* (Cooper).
   North Pacific.

4. *Archidoris kerguelenensis*, n. sp.
   North Pacific.

5. *Archidoris australis*, n. sp.
   North Pacific.

1. *Archidoris kerguelenensis*, n. sp. (Pl. I. figs. 1–12).

   ? *Doris tuberculata*, Cuv. ? Th. Studer, Die Fauna von Kerguelensland, Archiv f. Naturg., Jahrg. xlv., Bd. i. p. 128, 1879.

Habitat.—Kerguelen Islands, Pacific Ocean.

The form mentioned by Studer is probably the same as that now described. There was only one individual of this species, taken January 17, 1874, off Royal Sound, Kerguelen, lat. 49° 40′ S., long. 70° 20′ E., depth 25 fathoms.

[1] Bergh, Malacolog. Untersuch., *loc. cit.*, Heft xiv., 1878, p. 578; Supplementheft i., 1880, pp. 36–40.

[2] R. Bergh, Beitr. zur Kenntn. d. japan. Nudibr. II., Verhandl. d. k. k. zool.-bot. Gesellsch. Wien, Bd. xxxi., 1881, pp. 222–227.

This specimen, which was very well preserved and only slightly hardened, was nearly 4·5 cm. long by 1·8 cm. broad and 1·2 cm. high. The breadth of the mantle-border came to 4·5 mm., of the foot to about 12 mm.; the length of the tail was 5 mm., the diameter of the transversely oval branchial opening nearly 8 mm.; the height of the retracted rhinophores was 4 mm., of the retracted gill nearly 5 mm.; the length of the tentacles 3 mm.; the largest dorsal papillæ were 1·3 mm. in diameter, and almost the same in height. The *colour* of the animal was yellowish throughout; in front and on the lateral portions of the back ochre-yellow, so too on the upper sides of the pedal border, but rather paler; the rhinophores and gill were yellowish-white.

The *form* of the body was an elongated oval, the border of the mantle not broad, rather powerful. The *back*, which is slightly convex, is entirely covered with (Pl. I. fig. 2) papillæ of various sizes[1] lying closely together, the smallest chiefly on the margin of the mantle. The *rhinophore-openings*, which lie pretty near the front, are roundish; the margin, which hardly projects at all, is furnished with small papillæ. The rhinophores are powerful; the club with about thirty to forty broad leaves, and with small terminal papilla. The transversely oval, wide *branchial opening* has a somewhat projecting, slightly scalloped margin, also furnished with small papillæ. The gill is formed of seven tripinnate leaves, arranged in the shape of a large horse-shoe. The *anal papilla* (2·5 mm. high), with its slightly scalloped margin, lies behind in the opening of the horse-shoe, which it completely fills; the fissure-shaped *renal pore* lies to the right at the base of the anal nipple. The *outer mouth* was contracted like a pore; on either side of it the fold-like *tentacle*, furnished with a longitudinal furrow. The *sides of the body* had almost disappeared; the contracted *genital opening* in the usual place. The *foot* is strong, only projecting slightly (about 2·5 mm.) from the sides of the body, and rather more in front (4·5 mm.); the anterior end rounded, with marginal furrow; the posterior end slightly pointed, somewhat rounded.

The intestines do not shine through any part of the body. The peritoneum is colourless.

The *central nervous system* is greatly flattened (fig. 1); the cerebro-pleural ganglia kidney-shaped, rather thicker before than behind, the two portions indistinctly separated; the pedal ganglia (fig. 1, *a*, *a*) a little larger than the pleural. The common commissure (fig. 1, *b*) rather wide and powerful. Each proximal olfactory ganglion (fig. 1) forms a small, roundish, short-stalked swelling at the origin of the nervus olfactorius, the distal ganglia olfactoria a small oval swelling at the root of the rhinophores. The buccal ganglia (fig. 1, *c*) are rather larger than the ganglia olfactoria proximalia, longish-oval in shape, and connected by a short commissure; the gastro-œsophageal ganglia are rather short-stalked, also longish-oval in shape, and have a single row of larger nerve-cells (fig. 1).

[1] R. Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp., Th. II. Bd. ii.), Heft xiii., 1878, Taf. lxiv. fig. 20 (*Archidoris tuberculata*).

The *eyes* (fig. 1) have coal-black pigment, with a chitinous-yellow lens; the optic nerves about half as long again as the eyes, one of them was pigmented black throughout its whole length, and there is a small ganglion opticum at the base of each nerve. The *otocysts* are spherical, rather larger than the eyes, and closely filled with from 200 to 300 of the usual otoconia. The leaves of the *rhinophores* are stiffened by (fig. 3) greatly hardened long spicules, which amount to ·035 mm. in diameter; there are a very great number of large spicules in the axis of the club, and in the stalk almost displacing the other tissue. The *dorsal papillæ* are rendered extremely stiff (fig. 2) by the spicules penetrating them, which are also present everywhere in the skin. These spicules, as well as those already mentioned, are usually very much hardened, very long, usually pointed at both ends, the surface being almost or perfectly even. There were commonly only a few hardened cells spread in the interstitial connective tissue, but there were besides some spicules spread around the efferent ducts of the anterior genital mass.

The very strong *buccal tube* was 6 mm. long; the three pairs of retractors the same as usual; the inside with the usual posterior circular and longitudinal folds. The very strong *bulbus pharyngeus* 8 mm. long, 6·5 mm. high, and 6 mm. broad; the sheath of the radula projecting downwards 3·8 mm. at the posterior end; the retractors and the structure of the bulbus on the whole much as usual. The labial disk covered with a strong soft cuticle; the buccal opening as usual. The *tongue* broad and powerful, the deep broad cleft and the margins of its contiguous parts covered by the pale chitinous-yellow radula. In the latter there were twelve rows of dental plates, of which the first four were more or less incomplete; eleven developed rows and four still imperfect rows lie, moreover, under the strong roof of the radula and in its thick sheath; the total number of the rows amounted to twenty-seven. There were thirty-eight dental plates (on each side) in the first complete, the fifth, row of the tongue, and the number seemed only to increase at most to two or three more towards the back. The colour of the plates was a pale chitinous-yellow. The length of the innermost plate on the hindermost part of the tongue came to ·2 mm., and the height of the hook to ·12 mm. The length of the plates amounted to about ·53 mm., and the height of the hook to about ·32 mm. The length of the outermost plate amounted to ·14 mm., the height to ·08 mm.; the length of the next plate to ·18 mm. with a height of ·14 mm.; the length and height of the following plate respectively ·25 mm. and ·25 mm. The plates were of the usual form, with the usual wing-shaped development of the body (figs. 4–9); the inner as usual being smaller, with proportionately thicker hook (figs. 4–7), the outer (fig. 9) with more slender hook and shorter body.

The *salivary glands* are yellowish-white, flattened, bent together in the middle, when extended about 1·5 cm. long, the right gland not reaching so far back as the left; the anterior half thinner, amounting hardly to one-third the diameter of the posterior half; the anterior part narrow, and gradually passing into the excretory duct; the posterior half about 3 mm. in breadth by ·75–1·2 mm. in thickness. The *œsophagus* is nearly

13·5 mm. in length, the diameter before and behind is nearly 1·5–·2 mm., whilst in the middle it increases to 5 mm.; numerous strong longitudinal folds on the inside. The *œsophagus* passes into the posterior part of the stomach lying to the right (fig. 10, *a*); the roundish opening of the biliary duct lies beside the cardia. The sac-shaped stomach is 8 mm. long and 5 mm. in diameter; the inside has strong longitudinal folds. The *intestine* (fig. 10, *b*) arises from the anterior end of the stomach, forms, as usual, an angle resting on the upper side of the *œsophagus* and of the anterior genital mass, and then runs almost in a straight line to the anal papilla. The entire length of the intestine came to nearly 2·8 cm., the diameter to from 2·5–1·75 mm.; the inside with a number of longitudinal folds which passed above into the folds of the stomach. The scanty *contents* of the digestive cavity were a soft mass of indeterminable animal remains.

The *posterior visceral mass* (liver) is nearly 1·8 cm. long, and 1 cm. broad, and ·9 cm. high in the middle. The upper side slopes obliquely before and behind, with a broad furrow, which is occupied by the renal chamber, on the right margin is a superficial furrow for the intestine. The anterior half of the under and of the right side is very much flattened (by the anterior genital mass); the anterior end having a broad submedial cleft for the stomach, the posterior end rounded. The lower side, which the hermaphrodite gland does not clothe, was greyish, and the substance, for the most part, greyish-yellow. The cavity is rather narrow, with the usual openings. The *gall-bladder* lies to the right below the stomach, and falls obliquely downwards; it is nearly 4 mm. long, pyriform, yellowish in colour, apparently opening into the biliary duct; the inside is set with thick papillæ in rows, the neck smooth.

The *pericardium* is elongated, 12 mm. long by 8 mm. broad. The yellowish *ventricle of the heart* 4 mm. long. The *blood glands* (fig. 1, *dd*) pass one into the other on the upper side of the central nervous system. They are altogether 7 mm. long, yellowish-white; the upper side is more convex and smooth, the lower side less smooth and flatter; the margins lobed; the posterior is swollen out into a small process towards the front on the lower side of the pleural ganglia.

The *urinary chamber* is wide, measuring as much as 6·5 mm. in breadth behind, and becoming narrower in front; the anterior end extending as a smooth, thin-walled cæcal sac, nearly 7 mm. long to 2·25 mm. broad, between the stomach and the intestine (fig. 10, *c*). The walls of the renal chamber show the usual openings, which are wider towards the back of the chamber and against the median line. The whitish-yellow *renal syrinx*, which is almost cylindrical, nearly 5 mm. long and 2 mm. in diameter, appears to open immediately into the renal chamber; the folds on the inside are rather thick and less numerous. The renal substance the same as usual.

The *hermaphrodite gland* is a thin, loosely connected whitish-yellow layer, covering the upper side of the posterior visceral mass as far as around its rounded margins, and also the upper part of the anterior end; there are large oogene cells and zoosperms in the lobes.

The thin, whitish duct of the hermaphrodite gland issues on the upper side of the cardia, and runs obliquely downwards to the *anterior genital mass*. The latter is large, 14·5 mm. long by 7·5 mm. broad, and 9 mm. high, yellowish-white, thicker before, tapering behind, the right side arched, the left side convex before and slightly hollowed out behind; the principal efferent ducts projecting 3 mm. The *ampulla* of the hermaphrodite duct is yellow, lying on the middle of the left side; it forms a few curves, and when extended is nearly 1 cm. long, and measures almost 1 mm. in diameter. The male branch of the ampulla is attached for a length of nearly 1·5 mm., and then passes into the *spermatic duct*, which forms several long loops, measuring when extended nearly 3·3 cm. by ·5 mm., in diameter, and winding on the front and on the inner side of the genital mass. Below the spermatic duct (fig. 12, *a*) becomes somewhat dilated, and forms the *penis* (præputium) (fig. 12, *b*), nearly 2 mm. long, the upper half of which is filled with the conical unarmed glans. Upon the anterior end of the genital mass lies the spherical, yellowish *spermatheca* (fig. 11, *a*), nearly 3·5 mm. in diameter, filled with sperma and detritus. The *vaginal duct* (fig. 11, *b*) is rather strong, running almost straight, nearly 7 mm. long by nearly ·75 mm. in diameter; the inner side with strong, mostly pinnate folds. The *uterine duct* rises nearer the vaginal (fig. 11, *de*), but is rather longer, about as thick as the last, but narrowed below, and opening near the root of the duct of the mucous gland. The spermatocyst is attached to the base of the uterine duct (fig. 11, *c*); it is also yellowish-white, sac-shaped, somewhat bent, measuring when extended 4·3 mm. in length, and swollen with spermatozoa. The *mucous gland* is very large, forming by far the largest part of the genital mass; its cavity was wide but empty; the *albuminiparous gland*, which projected in front on the left side, was yellower; the duct of the *mucous gland* had the usual fold. A vulvo-vaginal gland was not found.

2. *Archidoris australis*, n. sp. (Pl. I. figs. 13–18; Pl. II. fig. 13).

Habitat.—Indo-Australian Ocean, Kerguelen Islands.

There was only a single individual of this species, taken off Howe's Foreland, Kerguelen Island, January 27, 1874, at a depth of 95 fathoms.

This specimen, which was well-preserved in spirit, was 15·5 mm. long by 8·5 mm. broad and 6 mm. high; the breadth of the mantle-border came to 3 mm., the breadth of the foot to 4·5 mm., the length of the tail to 2·6 mm., the height of the (retracted) rhinophores to 2 mm., of the extended gill nearly to 2 mm. The *colour* of the back was yellowish with touches of faint green; that of the lower side of the mantle-border whitish, of the foot yellowish-white; the rhinophores and the gill of the same colour as the back.

The *form* is oval, the consistence as above. The *back* is entirely and pretty thickly

covered with nodules (Pl. I. fig. 15) of various sizes, up to ·5 mm. in diameter; the largest, fewer in number, short, cylindrical or rather hemispherical, and occasionally slightly constricted at the base. Similar nodules, partly large, partly smaller, are found on the margin of the simple round rhinophore-openings; likewise on the simple margin of the branchial slit, where they sometimes alternate in size (fig. 14). The club of the *rhinophoria* is strong, with nearly twenty-five broad, thin leaves. The *branchia* is composed of from eleven to twelve slender leaves, simple below, bipinnate and tripinnate above. The *anal papilla* is low, obliquely truncated; beside it, to the right, is the *renal pore*. The (external) *oral orifice* is strongly contracted; the *tentacles* short, fold-shaped. The *foot* strong; the anterior margin with deep furrow and rounded corners, the tail somewhat pointed.

The intestines are not visible through the body-wall at any point; the peritoneum is colourless.

The *central nervous system* (Pl. I. fig. 13) is not much flattened. The cerebro-pleural ganglia (fig. 13, *ab*) kidney-shaped, the two divisions almost equal in size; the pedal ganglia (fig. 13, *c,c*) roundish in outline; the large common commissure (fig. 13, *d*) distinctly showing at the roots that it is composed of three separate commissures. The proximal olfactory ganglia (fig. 13, *e,e*) are developed on one side of the nerve; the distal ones (fig. 13, *f*) rather smaller and roundish. The optic ganglia (fig. 13) are roundish, sessile, rather smaller than the olfactory ones (fig. 13). The buccal ganglia at least four times as large as the proximal olfactory, roundish in outline, and connected by a very short commissure (fig. 13, *g*). The rather short-stalked gastro-œsophageal ganglia (fig. 13, *h,h*) are developed on one side of the nerve; a little larger than the lower olfactory ganglia; the nervus œsophagealis major is bifurcated, showing on the branches small ganglia. A short-stalked ganglion genitale (fig. 13, *i*) is connected with the right pleural ganglion.

The short-stalked *eye* (fig. 13) has black pigment and an obscure chitinous yellow lens. The *otocysts*, visible under the magnifying glass as chalk-white points, are rather smaller than the eyes, spherical, filled with about sixty of the usual otoconia, of up to ·02 mm. in diameter. The thin leaves of the *rhinophoria* are without spicules. The tough *skin* and the dorsal tubercles (fig. 15) generally have only a few larger, crumpled, hardened spicules, and smaller groups of hardened cells. Only a few hardened cells in the *interstitial connective tissue*.

The *mouth tube* was large, nearly 3 mm. long, and the same in diameter; the three pairs of retractors and the inside as usual. The *bulbus pharyngeus* rather larger than the mouth tube, 3·5 mm. long by 2·75 mm. high and 2·5 mm. broad; the thick sheath of the radula still projecting 1·5 mm. behind; the retractors as usual; the labial disk covered with a strong, faintly yellow cuticle, with a narrow (slightly radiate) oral fissure. The glittering chitinous-yellow radula of the strong *tongue* with ten rows of teeth plates, and with traces of two former rows at the point; there were also in the radula-sheath thirteen

developed and four undeveloped rows, so that their total number amounted to twenty-seven. The first five (outer) rows were incomplete; in the first complete row, the sixth, there were thirty-three plates (on either side), and the number hardly increased towards the back. The *plates* were very pale yellow; the height of the five outermost plates (fig. 18) was ·08–·1–·12–·14–·18 mm.; the height then gradually increased, sometimes reaching ·25 mm., and again diminishing from the middle of the row inwards, and decreasing to about ·12 mm. (fig. 16). The form was as usual, the two outermost much more slender (fig. 18, *a*,*a*).

The *salivary glands* yellowish, elongate, bent at the middle and again ascending on the posterior end of the bulbus pharyngeus.

The *œsophagus* nearly 3·5 mm. long, with strong longitudinal folds on the inside. The *stomach*, which projects out of the fissure of the liver, is large, nearly 3·5 mm. long by 2·75 mm. broad and 1·4 mm. high. The *intestine* opens from its anterior end, and runs almost straight backwards; it is nearly 12 mm. long, and ·75 mm. broad almost throughout; the inside shows the usual longitudinal folds. The whitish, soft contents of the digestive cavity were a mass of indeterminable animal remains.

The *liver* is nearly 7 mm. long, by 5 mm. broad and 4·75 mm. high, shaped like a short cone; the hollowed anterior end with a small facet below (for the anterior genital mass); the outside colour grey, the substance yellowish. The hepatic cavity is tolerably wide with the usual crypts. The *gall-bladder* lies to the right below the stomach, a yellowish-white, elongate pyriform sac, nearly 1·75 mm. long, and measuring ·75 mm. in diameter at the bottom.

The *pericardium* and the heart as usual. The *blood glands* joined by a short neck on the upper side of the central nervous system, greyish-yellowish; flattened, especially the anterior gland; they were almost of equal size and quadrangular with rounded angles in outline, their largest diameter nearly 1·5 mm.—The yellowish *renal syrinx* melon-shaped; the urinary chamber narrow; the kidney, with a beautiful dendritic ramification, covering the whole upper side of the posterior visceral mass (Pl. II. fig. 13).

The grey *hermaphrodite gland* contrasts with the yellowish liver, which it covers as a thin layer; the small lobes without developed reproductive elements. The yellowish-white *anterior genital mass* was undeveloped, nearly 1·2 mm. long, and as much as 0·8 mm. broad and high. The *ampulla* of the duct of the hermaphrodite gland was somewhat short and thin. The spermatheca spherical; the spermatocyst sac-shaped, longer than the spermatheca.

This species appears to be distinct from the preceding, as is shown even by the form and the nature of the gill. They are both specifically distinct from *Archidoris montereyensis*.[1]

[1] Bergh, On the Nudibr. Gastr. Moll., &c., I., *loc. cit.*, pp. 107 (163), pl. xvi. figs. 10, 11.

Discodoris, Bergh.

Discodoris, Bergh, Jahrb. deutsch. d. malacozool. Gesellsch., Bd. iv. 1877, p. 61.
„ Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft xii., 1877, pp. 518–539; Supplementheft i. 1880, pp. 47–50; ii. 1881, pp. 108–112.

Corpus subdepressum, circumferentia rotundata vel ovali, ut plurimum molle, supra minute granulatum. Apertura branchialis leviter crenulata, stellata vel bilabiata. Margo anterior podarii bilabiatus, labium superius plus minusve fissum.

Laminæ labiales e baculis minutis formatæ. Lingua rhachide nuda, pleuris multidentatis dentibus hamatis.—Prostata magna; penis inermis.

This generic form is characterised by the *flattened shape* of the body, oval or roundish in circumference, and mostly of rather *soft consistence*, the dorsal side finely granulated. The branchial aperture crenulate, stellate, or bilabiate. The *tentacles* finger-shaped. The anterior margin of the foot with two lips, the upper one cleft in the middle. The *labial plates*, nearly surrounding the mouth proper, are composed of minute rods. The rhachis of the radula without plates; the pleuræ with many hook-shaped teeth. Prostate large; penis unarmed.

The *Discodorides* differ considerably from the *Platydorides* and the *Asteronoti*, and on the other hand approach the *Thordisæ*, which still present the villous dorsum, and lack the armature of the labial disk.[1]

Very little is known of the biological relations of this group. Alder and Hancock saw the spawn of *Discodoris concinna*. Elliot observed the animal shedding pieces of the brim of the mantle (in *Discodoris fragilis*).

The genus is particularly represented in tropical and subtropical seas; only a small number of species has hitherto been examined or described.

1. *Discodoris boholiensis*, Bergh.
   Philippine Sea.

2. *Discodoris meta*, Bergh.
   Philippine Sea.

3. *Discodoris cebuensis*, Bergh.
   Philippine Sea.

4. *Discodoris notha*, Bergh.
   Philippine Sea.

5. *Discodoris morphæa*, Bergh.
   Philippine Sea.

[1] *Cf.* my Malacolog. Untersuch., *loc. cit.*, Heft xii., 1877, pp. 540–542.

6. *Discodoris muta*, Bergh.
Antilles Sea.

7. *Discodoris modesta*, Bergh.
Philippine Sea.

8. *Discodoris schmeltziana* (Garrett), Bergh.
Pacific Ocean.

9. *Discodoris indecora*, Bergh.
Mediterranean.

10. *Discodoris pardalis* (Alder and Hancock).
Indian Ocean.

11. *Discodoris concinna* (Alder and Hancock).
Indian Ocean.

12. *Discodoris fragilis* (Alder and Hancock).
Indian Ocean.

13. *Discodoris vestita?* (Abraham).
Pacific Ocean, Straits of Magellan.

14. *Discodoris raripilosa?* (Abraham).
Habitat?

15. *Discodoris stragulata?* (Abraham).
Habitat?

Discodoris morphæa, Bergh (Pl. I. figs. 19–22; Pl. II. figs. 1–12; Pl. III. fig. 13).

Discodoris morphæa, Bergh, Malacolog. Untersuch., *loc. cit.*, Heft xii., 1877, pp. 536–539, Taf. lx. figs. 18–22; Taf. lxi. figs. 1–5.

Habitat.—Philippine Sea (Samboangan).

A single individual of this species was dredged (along with a specimen of *Ceratosoma cornigerum* and one of *Platydoris eurychlamys*), February 1, 1875, on the reefs near Samboangan, at a depth of 10 fathoms.

The individual, which was very well preserved in alcohol, was 6·2 cm. long by 6 cm. broad and 1·8 cm. high; the breadth of the border of the mantle 2·3 cm., of the foot 1·8 cm.; the height of the rhinophores 4·5 mm.; the breadth of the (contracted) branchial fissure 4 mm., the height of the gill 8 mm.—The *colour* of the dorsal side was

pale greyish-yellow, with scattered large (nearly 12 mm. in diameter), roundish, annular or irregular, brown-grey and black patches; the largest of these were on the back proper; the annular chiefly on the border of the mantle. The fundamental colour of the lower side of the mantle-border paler than that of the upper side. This fundamental colour was, however, replaced in the inner two-thirds by large brownish-black, mostly confluent patches, which therefore formed a broad band, interrupted here and there; and this, again, then formed irregular broad tongues, running here and there outwards and inwards above the sides of the body; small scattered patches, mostly a little paler in colour, were visible on the outer third of the lower side. The sides of the body are yellowish and blackish; the pedal sole principally black and blackish-brown, the sides and the margins yellowish; the upper side of the foot and of the tail like the sides of the body. The head of the same colour, but paler; the tentacles yellowish. The stalks of the rhinophores black-brown, with whitish terminal papilla. The gill dirty yellow and blackish-brown speckled; as also the anal papilla.

The shape of the animal as usual—roundish and depressed. The *back* itself was arched, with a broad, soft mantle-border, which was much broader (20 mm.) behind than before (10 mm.). The whole upper side of the animal was thickly covered up to and upon the margins of the rhinophore-openings and of the branchial fissure, with small (diameter ·5 mm. or less), slightly projecting, sessile, rounded nodules (Pl. II. fig. 1). The marginal portion of the mantle-border soft, strongly bent up and down, somewhat indented here and there; the lower side smooth, showing whitish reticulate marks shining through it under the magnifying glass. The (contracted) *rhinophore-openings* are situated at the points of knobs, which project about 1·5 mm., and are scalloped; the *rhinophores* themselves have a strong stalk, amounting to nearly a third of the whole height, the strong club has about forty broad leaves (on either side). The *branchial* fissure lies on the top of a knob, similar to that of the rhinophores, and is also scalloped, the scallops being again serrated. The gill is composed of six very strong tripinnate pinnæ. The (3 mm.) high cylindrical *anal papilla* is slender, truncated above, with a scalloped margin; the *renal pore* lies in front to the right, at the base of the anus. The *head* is small, with smaller finger-shaped *tentacles;* the outer mouth strongly contracted. The *sides of the body* are quite low; the strongly-contracted genital papilla in the usual place. The *foot* is strong and broad, the corners of the anterior end rounded, the posterior end somewhat narrowed and rounded; the anterior end has a tolerably deep furrow, the rather broad upper lip is fissured in the mesial line; the tail is about 4·5 mm. long.

The viscera are not visible through the body-wall at any point. The (pseudo-) peritoneum is colourless.

The *central nervous system* was rather flattened; it was with some difficulty separated by dissection from its loose but adherent capsule, and even then it was not easy to distinguish the ganglia, owing in part to their coarsely nodular structure. The

cerebro-pleural ganglia are short, rather longer than broad; the cerebral and the pleural ganglia are of nearly equal size; the pedal ganglia, lying at the outside of the middle of the former, nearly as large as the pleural and roundish in outline. The large common commissure is nearly half as long again as the mean diameter of the central nervous system; all the three commissures are contained in a common sheath. The proximal olfactory ganglia are rather small, nearly sessile; the distal ones at the base of the club being only a little smaller than the proximal, and roundish. The buccal ganglia are shortly-pyriform, plano-convex, the broad ends passing almost immediately one into the other; the gastro-œsophageal ganglia are short-stalked, nearly one-eighth the size of the preceding.

The *eyes* are very short-stalked, the greatest diameter ·3 mm., slightly flattened on the lower side, with pitch-black pigment and rather large pale-yellowish lens. The *otocysts* are visible as chalk-white points on the lower side of the central nervous system; they are almost spherical (Pl. I. fig. 19), nearly ·12 in diameter, and closely packed with some hundreds of the usual otoconia, the largest of which were ·009 mm. in diameter. The thin leaves of the *rhinophores*, furnished only here and there with isolated knots, were stiffened with long (up to about ·8 mm.), fusiform, strongly hardened spicules of about ·025 mm. in diameter. The spicules were still more numerous in the stalk and generally in the axis of the rhinophoria, where they had almost completely replaced the other tissue. The *tentacles* had a very large number of spicules lying in different directions, but diminishing in number towards the point. There were only a small number at the head. The very low nodules of the *back* were richly furnished with (figs. 20, 21) the usual kind of spicules, the points of which often projected (Pl. II. fig. 1) on the surface. A quantity of similar spicules, most of them very long, were present on the lower side of the mantle-border; they were placed very irregularly, and often formed large heaps and node-like points. The relation of the spicules was exactly the same in the sides of the body and in the pedal sole. There were only a few larger hardened cells and spicules present in the *interstitial connective tissue*, even in the periphery of the principal efferent ducts of the reproductive apparatus.

The *mouth tube* was large, nearly 6·5 mm. long, and 7 mm. broad behind, somewhat flattened; the inside, for rather more than the posterior third, was of a bluish-black colour. The three pairs of *retractors* were very strong, with an additional weaker more mesially situated pair above; the inside showed the usual upper circular fold and also the upper three-fourths of the longitudinal folds of the bluish-black colour shining through externally; longish spots of the same colour appeared thickly scattered below.—The *bulbus pharyngeus* was strong, nearly 6·5 mm. long by 7 mm. broad and 5·5 mm. high; the sheath of the radula still projecting backwards about 2·2 mm.; the long retractors very strong. The labial disk was large, and covered with a white cuticle; round about, and near the perpendicular buccal fissure, this last passes into a chitinous yellow *prehensile ring*, which only enters the mouth a little way, and has a mean diameter of ·8 mm. This

ring (Pl. II. fig. 2) was rather broader above (fig. 2, *a*), but otherwise of uniform breadth, interrupted in the mesial line both above and below; above by a narrow furrow, below by a broad interspace (fig. 2, *b*). The prehensile ring is formed of perpendicular, tolerably thin, small (figs. 3, 4) rods, which attain a height of ·18 mm. The *tongue* was large and broad, with a deep cleft, which was covered beyond the edge with the pale chitinous yellow, varying-coloured radula. In the latter there were eighteen rows of dental plates, and in the short, thick radula-sheath sixteen more developed rows and three imperfectly developed, so that their total number amounted to thirty-seven. There were the marks of two other rows, which had been lost, at the point of the tongue; the first six or seven were incomplete, and the plates often injured. There were seventy plates (on either side) in the eighth row of the tongue, and seventy-three at the upper root of the tongue, and the number seemed hardly to increase backwards. The *plates* were of a pale yellowish colour; the height of the outermost four amounted to ·075–·1–·14–·16 mm.; the height increased to nearly ·28 mm., and then gradually diminished, till in the three innermost plates it only amounted to ·1–·09–·075 mm. The plates (figs. 5–9) were of the usual shape, with the usual wing-like development of the inner border of the body (figs. 7, 8), with rather blunt hook. The narrow rhachis had a fine fold (fig. 5, *a*). The innermost plates (fig. 5, *b*,*b*) were provided with a low and thick hook, the outermost (fig. 9, *a*) with slender hook and short body. The structure of the pulp of the radula was as usual (fig. 10).

The *salivary glands* (fig. 11) were yellowish-white, the anterior half much thicker (as much as 2 mm.) than the posterior, which is pointed towards the end. In the specimen examined, the posterior half was turned forwards, and the posterior end only was (fig. 11, *b*,*b*) bent round the large commissure. The entire length of the glands amounted to about 2 cm. The ducts of the salivary glands (fig. 11, *a*,*a*) were short.

The *œsophagus* (Pl. I. fig. 22, *a*) was about 13 mm. long by from 3–2 mm. in diameter; the inside showed the usual longitudinal folds. The œsophagus, which became a little widened behind into a sac 5 mm. long, communicating immediately with the biliary duct, opened into the wide stomach. The *stomach* itself (fig. 22, *b*) is nearly 13 mm. long by 12 mm. in diameter and 8 mm. high, the greater part of it projecting freely before the liver (fig. 22, *dd*); the inside has fine longitudinal folds. The *intestine* (fig. 22, *ccc*), which sprang from the anterior margin of the stomach, ran down in front of the anterior end of the liver, lying in a furrow on the latter, rose again a little way, and then, embedded in a continuation of the furrow, passed on the upper surface of the liver near the right margin to the anal papilla. The length of the intestine when extended amounted to fully 5 cm., and had an almost constant diameter of 2·5 mm. The inside of the intestine was provided with fine longitudinal folds. The whole digestive cavity, from the buccal cavity to the anal papilla, was filled with food, composed of a spongy siliceous mass with long spicules, and enclosing small corals, little pieces of conchylia, and a small well-preserved *Rissoa* (?), 4 mm. long.

The *posterior visceral mass* (liver) (fig. 22, *dd*) was large, about 2·6 cm. long by 2·1 cm. broad and 1·4 cm. high; the posterior end was rounded; the anterior truncated end broad, above (fig. 22) with a broad fissure (longer above) for the stomach, and below with a broad facet for the anterior genital mass; on the upper side was the narrow mesial furrow for the urinary chamber, not very deep and running rather obliquely; to the right the broader furrow for the intestine. The liver appeared uncovered here and there on the lower half of the anterior end and on the lower side, in the form of pale dirty yellow streaks; everywhere else it was covered by the ochre-yellow hermaphrodite gland. The hepatic cavity was pretty wide, with wide crypts. The *gall-bladder* lay at the posterior end of the stomach, showing a small roundish facet on the surface of the liver (fig. 22), about 5·5 mm. high, and opening right in the front into the hepatic cavity.

The *pericardium* was large; the *ventricle* of the heart 6 mm. long. The *blood glands* were loam-grey, very much flattened, and completely separated from one another by the ganglion-mass. The anterior gland 4 mm. in greatest diameter with a thickness of ·6 mm., was angularly round with truncated posterior end; the posterior 4 mm. long, tongue-shaped, the point turning backwards.—The *musculi retractores branchiæ laterales* about 12 mm. long, having several heads; between these, running parallel to them, were the four weaker *musculi retractores branchiæ medii*, which pass on to the anal papilla and to the posterior leaves of the gill.—The *renal syrinx* was about 3·5 mm. long, pyriform; the duct strong and thick-walled. The urinary chamber narrow; the kidney strongly developed.

The ochre-yellow *hermaphrodite gland* covered the greater part of the liver (*vide* supra); there were large oogene cells and zoosperma in the lobes. The duct of the hermaphrodite gland rose above the cardia, and ran upwards obliquely to the posterior side of the *anterior genital mass*. The latter was large, nearly 8 mm. long (from before backwards) by 6·5 mm. broad and 14 mm. high; the efferent ducts, moreover, projected nearly 3 mm. It was high, slightly compressed from the front backwards, with an external, anterior and posterior face; the prostate lies on the flattened lower side; the duct of the hermaphrodite gland runs down on the posterior side and forms the ampulla on the lower margin; the brown-yellow albumen-gland lies exposed in the middle behind the hermaphrodite duct; the spermatic duct, ascending to the penis, projects on the anterior side. The opaque yellow-white *ampulla of the hermaphrodite duct* (Pl. III. fig. 13, *a*), forms a series of flexions on the lower margin of the genital mass inside from the prostate; in the specimen examined it measured when extended 1·5 cm. long and ·7 mm. broad. The short male branch (Pl. III. fig. 13, *c*) passing into the yellowish-grey somewhat compressed *prostate* (fig. 13, *cd*); the first part of the latter was nearly 14 mm. long by 5 mm. in greatest diameter; the lower terminal end was nearly 6 mm. long, narrowed (like the upper), yellower, bent and attached to the preceding part. The cavity extending through the whole organ was narrow. The prostate became gradually smaller and passed into the *spermatic duct* (fig. 13, *e*), which was about 8·5 mm. long, tolerably

strong and slightly coiled, and passed into the much thicker penis, which was about 3 mm. long (fig. 13, *f*). The latter (the præputium) has strong internal, longitudinal folds; the opening of the spermatic duct lies above at the bottom of the cavity. The *spermatheca* was spherical, 8 mm. in diameter, nearly empty. The *spermatocyst* was sac-shaped, bent, 3·5 mm. long when extended (Pl. II. fig. 12, *a*), crammed with spermatozoa. The inner half of the uterine duct (fig. 12, *c*) was much thinner than the outer and than the vaginal duct (fig. 12, *b*). The *mucous gland* was white, showing very fine twistings throughout. The albumen gland was brownish-yellow, large, nearly half of it laid bare on the posterior side of the genital mass. The cavity of the mucous gland was empty; the duct showed the usual double fold, much higher towards its outer end.

From immediate comparison with the original specimen of *Discodoris morphæa*,[1] the form described above seems merely to represent a *darker variety* of the same, with much stronger and darker colouring of the dorsal side, and with confluence of the darker patches of the lower side of the mantle-border. One point may perhaps throw a doubt on the identification of the species, viz., the absence of stronger false median dental plates, of stronger thickenings on the rhachis,[2] which were distinctly wanting along the whole length of the rhachis in the individual here examined.

Platydoris, Bergh.

Doris (L.), d'Orbigny, Moll. des îles Canaries, 1834, p. 38.
Argus (Bohadsch), Mörch. Journ. de Conchyl., sér. 3, t. iii., 1863, p. 31.
Platydoris, Bergh, Jahrb. d. deutsch. Malacozool. Gesellsch., iv., 1877, p. 73.
„ Idem, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft xii., 1877, pp. 495–517, Supplementheft i., 1880, pp. 57–66.

Corpus coriaceum, rigidum, applanatum, circumferentia ut plurimum ovali vel rotundata, limbo palliali lato; nothæum minutissime granulatum. Apertura branchialis paucilobata, stellata; tentacula digitiformia; podarium margine anteriore bilabiatum, labio superiore profunde fisso.

Armatura labialis nulla. Lingua rhachide nuda, pleuris multidentatis, dentibus hamatis.—Prostata magna. Penis orbiculis duris hamigeris armatus; vagina armatura simili vel cuticula crassiori instructa.

This genus was established by me in 1877, and appears to form a very natural group.

These animals are usually of rather large size, roundish or oval, and depressed; the skin is hard and leathery; the dorsal surface granular; the edge of the mantle very large,

[1] The originals of Semper's collection of Nudibranchiata, mostly given to me by himself, were handed over by me to the collection in the University Museum of Copenhagen (Steenstrup).

[2] *Cf. loc. cit.*, p. 538, Taf. lxi. fig. 1, *aa*, *aa*.

the branchial aperture few lobed and stellate; the tentacles finger-shaped; the anterior margin of the foot bilobed, the upper lip cleft in the middle.—The labial disk is unarmed. The radula has a naked rhachis and a large number of hook-shaped lateral teeth. The præputium is armed with rows of hard flat disks, each bearing a hook; the vagina has a similar armature, or at least a strongly developed cuticle; the prostate is large.

Platydoris is not unlike *Asteronotus*, which differs, however, in being softer and smoother, and in possessing an unarmed penis and vagina, and a special dart and gland. *Hoplodoris*[1] comes near *Platydoris*, but differs in being softer, in the armature of the labial disk, and in possessing a dart like *Hoplodoris*. *Dictyodoris* agrees with *Platydoris* in the hardness of its outer skin, and in the unarmed labial disk, but differs in the smoothness of the dorsal surface, and in the unarmed condition of the penis; it has no dart.[2]

The genus is confined to the tropical seas. Not much is known about its habits, except that its movements are lethargic and slow. Quoy and Gaimard observed the copulation of *Platydoris scabra*, and the throwing off of pieces of the mantle in other species.[3]

The following list contains all the known or mentioned "species":—

1. *Platydoris argo* (Linné).
   Mediterranean.

2. *Platydoris philippi*, Bergh.
   Mediterranean.

3. *Platydoris angustipes* (Mörch).
   West Indies.

4. *Platydoris eurychlamys*, Bergh.
   ? *Doris solea*, Cuvier.
   Philippine Sea.

5. *Platydoris arrogans*, Bergh.
   Philippine Sea.

6. *Platydoris striata* (Kelaart).
   Indian Ocean.

7. *Platydoris ellioti* (Alder and Hancock).
   Indian Ocean.

[1] R. Bergh, Malacolog., Untersuch., *loc. cit.*, Supplementheft i., 1880, pp. 51–55.
[2] R. Bergh, *loc. cit.*, pp. 75–78.
[3] A similar phenomenon has been described in species of the genera *Discodoris* and *Peltodoris*.

8. *Platydoris formosa* (Alder and Hancock).
Indian Ocean.

9. *Platydoris brunnea*, Bergh.
Philippine Sea.

10. *Platydoris punctata* (d'Orbigny).
Atlantic Ocean (Canary Islands).

11. *Platydoris canariensis* (d'Orbigny).
Atlantic Ocean (Canary Islands).

12. *Platydoris variolata* (d'Orbigny).
East Pacific.

13. *Platydoris punctuolata* (d'Orbigny).
East Pacific.

14. *Platydoris scabra* (Cuvier).
Pacific Ocean.

15. *Platydoris* (?) *variegata*, Bergh.
Pacific Ocean.

16. *Platydoris vicina*, Bergh.
Pacific Ocean.

17. *Platydoris coriacea* (Abraham).
Indian Ocean (Seychelles).

18. *Platydoris inframaculata* (Abraham).
Indian Ocean (Amboyna).

19. *Platydoris tabulata* (Abraham).
Habitat ?

20. *Platydoris hepatica* (Abraham).
Pacific Ocean (Riciniola).

21. *Platydoris speciosa* (Abraham).
Indian Ocean (Amboyna).

22. *Platydoris murrea* (Abraham).
Indian Ocean (Mauritius).

23. *Platydoris* (?) *sordida* (Quoy et Gaimard).
Indian Ocean (Ile de France).

Platydoris eurychlamys, Bergh (Pl. II. figs. 18–24; Pl. III. figs. 1–12).

Platydoris eurychlamys, Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft xii., 1877, pp. 510–513; Taf. lix. figs. 11–18; Taf. lx. figs. 1, 2. Supplementheft i., 1880, pp. 61, 62; Taf. E. figs. 10, 11.

Habitat.—Philippine Sea (Samboangan).

A single specimen was taken on February 1, 1875, from a depth of 10 fathoms, at Samboangan, together with *Ceratosoma cornigerum* and *Discodoris morphæa*, and well preserved in alcohol.

The specimen, which was somewhat strongly hardened and rather bent, measured 8 cm. long by 4·8 in breadth and 1·6 cm. in height; the breadth of the mantle edge in front was 1 cm., at the sides and behind 2 cm.; the breadth of the foot about 1·5 cm., the length of the tail 6 mm.; the height of the rhinophorial bosses 2·5 mm., the apertures measuring about 2 mm.; the breadth of the branchial slit about 12 mm.; the height of the rhinophoria 6·5 mm., of the branchia 10 mm., and of the anal papilla about 5 mm.; the length of the tentacles 3 mm.—The *colour* of the whole upper surface brownish-grey; the sides of the body were about the same colour, as were also the margins of the foot, but still somewhat lighter; the under side of the mantle edge was a clear yellowish-white, so also the head and tentacles; the rhinophoria were greenish-grey, the leaves of the gill blackish-grey, but the rhachidian parts yellowish-white; the sole of the foot was yellowish-white.

The *form* of the body was much as usual. The broad mantle edge was undulated at its margin; the *dorsal surface* hard, somewhat rough to the touch, because it is covered all over with extremely fine knots. The *rhinophorial bosses* were about 5·5 mm. in diameter, with a crenate opening; the stem of the retracted rhinophore was about one-third of its whole extent; the club was provided with at least fifty broad lamellæ on each side. The wide branchial cleft was five-lobed, two in front, the largest behind, and one on either side; the height of the largest lobe was 6 mm. The branchia was made up of six tripinnate leaves; in front of the hindermost ones, and between them, was the cylindrical truncated *anal papilla;* close to the base of which, and slightly to the right, was the round *orifice of the renal organ.* The genital opening was strongly retracted. The anterior margin of the *foot* had a shallow furrow, the posterior end was rounded.—The peritoneum was quite colourless.

The strongly flattened *central nervous system* was enclosed in a narrow tough cap-

sule, which showed a white dotted appearance under the lens, due to the presence of a number of somewhat round yellowish hard cells, occasionally there were a few long spicules not strongly hardened. The upper surface of the ganglia was coarsely granular in appearance. The cerebro-pleural ganglia were reniform, the two divisions of about equal size and hardly distinguishable from each other; the pedal ganglia had a circular contour, and were about equal in size to the pleural. The large common commissure was hardly half as large as the diameter of the whole nervous system. The proximal olfactory ganglia (Pl. III. fig. 2, *a*) were nearly sessile and bulb-shaped; the distal form swellings about the same size upon the nerves (fig. 2, *b*). The buccal ganglia (fig. 1, *a*) were slightly smaller than the olfactory, egg-shaped, and united with each other directly; the gastro-œsophageal (fig. 1, *b*,*b*), being about one-sixth the size of the buccal, attached by a short stalk to the side of the nerve.

The *eyes* are attached by a short stalk to a hardly distinguishable ganglion; their pigment is black and the lens yellow. The *otocysts* are a trifle smaller than the eyes, and contain a quantity of otoconia, about two or three hundred of the usual kind; they are visible beneath the lens as chalk-white points. The broad, rather thin lamellæ of the *rhinophorial club*, as might be seen by a lens, were covered upon their surfaces, but not on their margins by small pigment spots; they contained numerous long rod-like pointed spicules, of a diameter of ·03 mm. scattered throughout. Through the stalk and on the walls of the cavity of the rhinophoria the tissue was filled with numerous quite similar spicules, sometimes rather stronger; the retractors of the rhinophoria were as in other species.[1] The *skin* of the back was filled everywhere with spicules like those just mentioned; the point-like knots on the back filled with spicules radiating outwards, and sometimes reaching the surface (Pl. II. fig. 21). In the *interstitial connective tissue* were generally a number of round hard cells,[2] but only exceptionally spicules.

The *buccal tube* had a yellowish-white colour, both inside and out; it was 6·5 mm. long by 5·5 mm. broad behind; the three pairs of retractor muscles had quite the usual form. The strong *bulbus pharyngeus* was 7 mm. long by 6·5 mm. in breadth and 6·7 mm. in height; the radula-sheath projected 3·25 mm. behind; the strong retractor muscles as usual. The arched labial disk was covered with a strong white cuticle; with a perpendicular mouth-slit somewhat wider above. The *tongue* was strong; the chitinous-yellow *radula* was provided with twenty-four *series of teeth*, within the radula-sheath and below the tectum radulæ there were twenty-seven fully developed and three undeveloped series; the total number being thus fifty-four. The first five or six rows were more or less incomplete; in the seventh there were on either side ninety-one teeth, and the same number in the twenty-fourth row; further back there was only an increase of at most two or three in the number of teeth to each series. The *teeth* were a clear yellow; the height of the three outermost was about ·09, ·1, and ·12 mm. respectively, and the

[1] *Loc. cit.*, p. 511.

[2] *Loc. cit.*, Supplementheft i., 1880, p. 61, Taf. E. fig. 10.

height of the plates increased gradually to ·3 mm., while the innermost of all (fig. 18, *a*,*a*) were only about ·1 mm. The shape of the teeth was as usual (Pl. III. fig. 6). The three outermost (Pl. II. fig. 19) had a very shortened body; the outermost (figs. 19, *a*,*a*, 20) upright, with a somewhat variable shape.

The *salivary glands* were about 2·8 cm. long and somewhat bent in the middle, the hinder end only reaching a short way beyond the large common commissure; in the most anterior part (Pl. III. fig. 11, *b*) they were yellowish in colour for an extent of about 6 mm., 2 mm. broad, and somewhat flattened; for the rest of their length (fig. 11, *a*) they were white and somewhat flattened, narrower in the hindermost portion, about ·3–·4 mm.; the cavity of the gland was quite narrow. The ducts short.

The *œsophagus* about 2·3 cm. long with a diameter of 1·5–2·3 mm. behind, and a little before its junction with the stomach the width was slightly greater (fig. 3, *a*); the interior had fine longitudinal folds. The sac-shaped *stomach* (fig. 3, *b*) extends some way in front of the cleft of the liver, and is about 1·5 cm. long by 1·2 cm. in breadth and ·8 cm. in height; its cavity communicates with that of the liver (fig. 3, *d*) by a very wide aperture; the interior is covered with close, low, longitudinal folds. The *intestine* takes its origin from the anterior end of the stomach (fig. 3, *c*), it immediately bends to the right, resting upon the œsophagus and anterior genital mass, then posteriorly it traverses a winding furrow upon the liver; its total length when fully extended is 6 cm., with a constant breadth of 2–2·5 mm.; the interior is covered with fine folds. The alimentary cavity was filled with the débris of food, generally consisting of indistinguishable animal remains, but sometimes of masses of sponges and Radiolaria-like convex bodies of 1·5 mm. in diameter.—The posterior visceral mass (*liver*) is 2·3 cm. long by 1·6 cm. in breadth and 1·4 cm. in height; the hinder end is rounded and truncate; the anterior end is obliquely inclined from above forwards and downwards, and hollowed out to receive the stomach; beneath on the right it has a facette for the anterior genital mass. About the middle line is the furrow for the intestine, and along its left margin the furrow occupied by the urinary chamber. The liver is darker inside than out, its colour is dirty yellow. The cavity has numerous wide crypts filled with food débris. The *gall-bladder* is of the same colour as the liver, pear-shaped, and situated on the left side of the stomach; it is 5·5 mm. long, with an average diameter of 2 mm. on the surface of the liver (the roundish facette is here somewhat sunken in the middle).

The *pericardium* is large and roundish; its length is 12 mm. and the breadth about the same; the walls thicker than usual (pathological ?), especially thickened round the margin.[1] The *ventricle of the heart* is 6 mm. long, and its upper surface covered with epithelial villi (fig. 10) of various size, found also on the auricle, and reaching a length of ·5 mm.; the two atrio-ventricular valves being strongly developed and the musculature of the

[1] In the pericardium I found the much mutilated female of a parasite belonging apparently to the genus *Briarella*, formerly instituted by me (Malacolog. Untersuch., *loc. cit.*, Heft x., 1876, p. 408, Taf. xlix. figs. 11–13) from a specimen

ventricle very strong. The *blood glands* are flattened and of a whitish-yellow colour, separated from each other by the central nervous system. The anterior is somewhat transversely-oval and bent in the transverse axis; its greatest diameter is 4·5 mm., its thickness 1·3 mm. The posterior gland is rather long, 7·5 mm., broader in front, about 6 mm. and 1 mm. thick.—The two strong *retractores branchiæ* are about 1 cm. long, and are made up of a number of separate but interlaced fascicles; their course is oblique.

The *renal syrinx* is short and melon-shaped, of a greater breadth than length, the greatest diameter being 2·5 mm; it is yellowish in colour; the interior has very strong longitudinal folds, which, by their yellow colour, contrast markedly with the brown-coloured arborescent villi of the duct; these latter (fig. 5) increase in size towards the lower part. The short and strong duct, of a greyish-brown tint, is conspicuously visible through the wall of the urinary chamber, which is 2·5–2 mm. broad anteriorly and about 3 mm. posteriorly. The anterior end of the chamber bifurcates at about the middle of the liver, and the right branch lies in the intestinal furrow; along the floor of the chamber runs on the right side about as far as this bifurcation, the thick duct of the renal syrinx (fig. 4, *b*), which at this place opens by a wide oblique cleft (fig. 4, *a*), conspicuous by its brown papillose tufts (fig. 4). The structure of the kidney was quite as usual.

The *hermaphrodite gland* covers the liver with a nearly continuous layer of a somewhat brighter colour; in the lobules of the gland are large oogenous cells and spermatozoa. The *anterior genital mass* is large and compressed, and somewhat heart-shaped, with an outer arched and inner more convex surface, and an obliquely flattened anterior surface; the upper and hinder margins sharper but rounded; the lower margin more flattened; the length of the entire mass about 14 mm. by 11·5 mm. in height, and 17 mm. in breadth. On the anterior surface are the vesiculæ seminales and genital ducts; the larger part of the inner side forms the dirty yellow albuminiparous gland, on the under side of which lies the ampulla of the hermaphrodite duct, winding farther forwards and outwards along the broad lower surface. The slender whitish *duct of the hermaphrodite gland* (fig. 12, *a*) winds above the exit of the main bile duct, traversing obliquely to the anterior genital mass, and forming a whitish coiled *ampulla* (fig. 12, *bc*), which, when unrolled, measured about 1·5 cm. with a diameter of some 1·5 mm. Theshort slender *male duct* (fig. 12, *e*) opens into the plano-convex heart-shaped *prostate* (fig. 12, *f*). This latter is about 3 mm. long, and has a narrow cavity. The first 8 mm. of the *vas deferens* (fig. 12, *g*) are thin, but it increases in thickness farther on and becomes muscular (fig. 12, *h*); the vas deferens then passes into the thicker *penis* (fig. 12, *ii*), cylindrical in form, and about 15 mm. long. For the whole of its length, the penis, and especially its *præputium*, is lined with a thick

found in *Ceratosoma trilobatum*. The female was 12 mm. long, of which 2·5 belonged to the tail, with six pairs of sac-like appendages of the abdomen. The form was very similar to that of *Briarella microcephala*. There were no egg-bags; on the wall of the pericardium, however, there were scattered a number of round or oval yellowish eggs ·1 mm. in diameter. I discovered also in the cavity of the pericardium three males, about 2–2·5 mm. long, like those I previously found in *Chromodoris elisabethina* (*loc. cit.*, Heft xi., 1877, p. 472, Taf. li. fig. 16a).

pale yellowish cuticle, which forms strong folds with here and there scattered disk-like structures. These *disks* are arranged in irregular (quincuncial) series, of which there are from 7 to 8 below and from 4 to 5 above; altogether, I found seventy-two of these disks. They are of roundish or oval contour, and both forms occur above (Pl. III. fig. 23) and below (Pl. II. fig. 9) within the præputium. Their greatest diameter varies between ·8 and ·25 mm., and plates of the two extreme sizes were found both above and below. The more or less arched upper surface (fig. 8) of the disks is prolonged into a hook, about ·18 mm. high, which is often very sharply bent; the stroma of the disk is frequently prolonged into the hook (Pl. II. fig. 24), in others the stroma seems to be withdrawn, leaving small air-containing spaces (fig. 24). At the base of the cavity of the præputium is the cylindrical *glans*, about ·8 mm. long, and covered with a simple cuticle; it is traversed by the seminal duct, opening by an oval aperture at its summit (fig. 23). As it passes into the vestibulum the præputium is strongly pigmented. At the lower end of the penis opens the whitish vestibular gland (Pl. III. fig. 12, *k*), about the size of the prostate, and rather compressed; it is sessile and has a largish cavity. The *spermatheca* (Pl. II. fig. 22, *a*) is spherical and about 6 mm. diameter, whitish in colour, and filled with semen and detritus. The stout vaginal duct is, including the long vagina (fig. 22, *b*), about 12 mm. long, and lined throughout by a strong yellow cuticle raised into 6–8 folds, which are especially strong in the vagina, and can be seen from the outside; the lowest end of the vagina (fig. 22, *c*) is brown coloured. The uterine duct (fig. 22, *dd*) is thinner and shorter than the vaginal, only 6 mm. long; at its lower end is the *spermatocyst* (fig. 22, *e*) attached by a short stalk; it is sac-shaped, yellow in colour, about 3·5 mm. in length, and was full of semen. The broad white upper margin of the *mucous gland* has fine gyri; quite in front there is a more yellowish portion; the rest of the outer side of the mucous gland is white, with a few thick windings. The larger part of the hinder side and the under margin was taken up by the large dirty yolk-yellowish *albuminiparous gland*; the duct of the mucous gland has the usual internal fold; the *vestibulum genitale* shows logitudinal folds.

In all probability the form described here is identical with the *Platydoris eurychlamys*, formerly investigated by me, though it presents a few differences, such as the greater number of disks in the præputium and their somewhat different form. An investigation of a number of individuals, however, would perhaps show a great variability in the armature of the penis; and perhaps the species *Platydoris vicina*, lately instituted by me,[1] may prove to be merely a variety of this.

Another specimen of the same species was dredged during the Challenger Expedition on the Reef of Tongatabu, from a depth of 8 fathoms. It was strongly bent; when

[1] Supplementheft i., 1880, pp. 62, 63, Taf. E. figs. 16–20.

straightened it measured 4·3 cm. The rhinophoria were deeply retracted but existed; the branchia and a large portion of the branchial cleft were missing, and all the alimentary tract as far as the buccal tube. Another animal had very likely entered through the branchial cleft, and had eviscerated its host.

Thordisa, Bergh.

Thordisa, Bergh, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. d. Philipp. Th. II. Bd. ii.), Heft xii., 1877, pp. 540–542.

Forma corporis fere ut in Discodoridibus; tentacula tuberculiformia; branchia paucifoliata.

Armatura labialis nulla. Lingua rhachide nuda, pleuris multidentatis; dentes hamati.—Penis inermis.

This genus, to which the species to be presently described can be only doubtfully assigned, is as yet but little known. In the general form of the body it comes near *Discodoris*, but differs in the entire absence of labial plates. The armature of the tongue, however, is similar; the rhachis is naked and provided with numerous lateral teeth, of the usual hooked form. The penis is unarmed.

The three following species which the genus contains are but little known; they are all tropical forms, but nothing is known of their mode of life.

1. *Thordisa maculigera*, Bergh.
   Philippine Sea.
2. *Thordisa villosa* (Alder and Hancock).
   Indian Ocean.
3. *Thordisa? clandestina*, n. sp.
   Pacific.

Thordisa clandestina, n. sp. (Pl. III. figs. 21–25).

Habitat.—Western Pacific (Torres Strait).

A single specimen was taken on September 8, 1874, at Torres Strait (Station 186, lat. 10° 30′ S., long. 142° 18′ E.; depth, 8 fathoms; bottom, coral sand).

The specimen was well preserved in alcohol.

Its *length* was 18 mm., breadth 9 mm., and height 6 mm.; the breadth of the mantle edge 3·5 mm., of the foot 6·5 mm.; the length of the tail 1·75 mm., the height of the extended rhinophoria 3 mm., of the (outstretched) branchia 2·5 mm. The *colour* was whitish; on the back were a number of brownish-black spots, which also were present and more abundant on the sides of the body and under-surface of the mantle edge; the

club of the rhinophore was of a greyish-chocolate colour, and the gill-leaves showed a similar colouring.—The animal was of a softish consistency.

The *form* of the body was a longish-oval, somewhat flattened; the dorsal surface quite even; the mantle edge projecting about 1–3·5 mm., and most strongly developed behind. The rhinophorial cleft oval, with a slightly prominent margin; the stem of the *rhinophore* is strong and somewhat compressed; the strong club, bent backwards, is about as long as the stalk, its upper side is somewhat flattened, the under somewhat keel-shaped, the number of leaves on each side is about twenty-five. The *branchial cleft* is transversely oval (of about 2·5 mm. diameter), with a slightly prominent reversed margin; the branchia is formed of five tripinnate leaves, of which the two hindermost are very deeply cleft, so that there appear to be seven divisions. Behind the branchial arch, and completing it, is the somewhat cup-shaped *anal papilla*, which has a crenate margin; at its base in front is the fine *renal pore*. The wrinkled genital papilla occupies its usual position. On either side of the stellate mouth-aperture is a strong knob-like *tentacle*, with a longitudinal furrow on the outside which is deeper at the end. The foot is rounded anteriorly and posteriorly, and does not stand out much from the sides of the body; on its anterior margin is a fine furrow.

The intestines are hardly visible from the exterior. The peritoneum is colourless.

The *central nervous system* is strongly flattened. The cerebro-pleural ganglia are longish; the line dividing the two parts is very distinct, especially on the outer margin; the pedal ganglia are larger than the pleural, and lie outside the middle part of the cerebro-pleural; they are of a short oval form and are almost divided into two parts. The common commissure composed of the three ordinary divisions; at the base of the hindermost (pleural) is a small ganglion genitale. The sessile bulb-shaped proximal olfactory ganglia are united with the equally sized distal by a winding nerve. The buccal ganglia are roundish, and about the same size as the last, united by a commissure so short as hardly to merit the name; a small swelling on the *nervus gastro-œsophagealis* represents its ganglion.

The *eyes* are nearly sessile, with black pigment and a yellow lens. The *otocysts*, visible under a lens as small chalk-white bodies, are about as large as the eyes, and are filled with a mass of brownish-yellow otoconia, each about ·02 mm. long (mostly possessing what appeared to be a nucleus). The broad, rather thin lamellæ of the *rhinophores* have no spicules. The *skin* of the back has no large spicules and but few hardened cells, which were also nearly absent in the *interstitial connective tissue*.

The *buccal tube* is strong, 3 mm. long, and has the ordinary three pairs of retractor muscles; its interior is as usual. The *bulbus pharyngeus* is strong, 3 mm. long by 2·5 mm. broad and 2·6 mm. high; the radula-sheath projects downwards about ·4 mm.; the strong retractor muscles are as usual. The *labial disk* has a covering of a thick white cuticle without any trace of armature; the mouth opening is four-rayed. The *tongue* is broad,

flattened, with a deep dorsal furrow; the yellow-coloured radula has sixteen series of teeth, the four anterior of which were incomplete, on the apex of the tongue there were traces of two other series that had become detached; further back, beneath the tectum radulæ and within the radula-sheath, were thirteen developed and three undeveloped series,—the total number being thus thirty-two. In the fifth series of the tongue there were seventy-six teeth on each side, and the number appeared not to increase much further back. The colour of the teeth is a clear chitinous yellow. The heights (Pl. III. figs. 22, 25) of the outermost (behind on the tongue) are about ·056–·07–·075–·08 mm.; the height then gradually increases to about ·12 mm., and then decreases again to ·8 mm. (fig. 21). All the teeth are of the usual simple form (figs. 23, 24), with the usual "winged" base; the outermost being more upright, with shorter base (figs. 22, 25, *aa*).

The *salivary* glands are yellowish and long (5 mm. by ·7 mm. broad), reaching to the under side of the stomach; in shape flattened and band-like; the efferent ducts short.

The *œsophagus* is short and wide, about 4·5 mm. long, with strong folds on its inner surface, which end obliquely at the cardia, but are prolonged into the stomach, where they are much more slightly developed. The *stomach* is large, about 6 mm. long by 4 mm. broad, and reaches as far as the *bulbus pharyngeus*. The alimentary tract was full of the remains of sponges and corallines, and other unrecognisable animal débris. The *intestine* arises from the anterior margin of the stomach, and runs straight backwards; its length is about 13 mm. and diameter ·75 mm.

The *liver* is about 7·5 mm. long by 5 mm. in breadth and 5 mm. in height; the broad anterior portion is obliquely truncated downwards, and is excavated to receive the hinder end of the stomach; the narrower hinder end is rounded. The colour of its upper surface is a clear grey, the tissue itself is dirty yellow coloured; the cavity large and round. I could find no gall-bladder.

The *heart* is large, the ventricle 2 mm. long. The *blood gland* lies behind the central nervous system, and is oval in form, whitish in colour, and slightly lobulated at its outer edge; its length is 2·4 mm.—The *renal syrinx* is yellowish-white, melon-shaped, and 1 mm. in greatest diameter, with strong interior folds visible from the outside. The *kidney* is strongly developed.

The *hermaphrodite gland* covers the liver; it contained no developed genital products. The *duct* takes its rise above the cardia; its ampulla is yellowish-white, and forms a slight swelling. The *anterior genital mass* was somewhat undeveloped, of an oval compressed form, barely 1·5 mm. long, and whitish in colour. The vas deferens is not long; the penis is unarmed. The state of the vesiculæ seminales I was unable to observe.

Whether this animal really belongs to the genus *Thordisa* or not must be left uncertain for the present. The smoothness of the body, and the shape of the outermost plates, seem to make the generic position of the animal somewhat doubtful.

Bathydoris, n. gen.

Corpus fere semiglobosum, molle; dorsum papillis conicis parvis ubique sparsis, margine palliali vix ullo; rhinophoria retractilia clavo perfoliato; tentacula sat magna, nonnihil applanata, acuminata; branchia e fasciculis discretis compluribus (6) fruticulosis non retractilibus formata; podarium sat latum.

Bulbus pharyngeus permagnus; armatura labialis nulla; mandibulæ magnæ, sat applanatæ, margine masticatorio lævi, processu masticatorio nullo; series radulæ multidentatæ, dens medianus nonnihil compressus, dentes laterales hamati, interni parte basali latiori, reliqui angustiori.—Penis conicus inermis, glande pagina inferiore fissura instructa.

This remarkable genus differs from all other Doridida proper in the *semiglobular form of the body*, which is something like the genus *Kalinga* of Alder and Hancock,[1] which it also resembles in the characters of its branchia *composed of several separate branchial tufts*, and in the development of soft conical papillæ upon the *back*. *Bathydoris* has no frontal appendages, and the dorsal margin is very slightly pronounced. In its internal structure, however, *Bathydoris* differs entirely from *Kalinga* and other Polyceradæ.

The gigantic *bulbus pharyngeus* differs from the same organ in all other Doridida, *and resembles rather that of Bornella*[2] and other Tritoniadæ; the labial-disk is unarmed, the *powerful mandibles are covered by a thick muscular mass*. The radula is not unlike that of the Tritoniadæ, possessing as it does a median tooth and a series of lateral teeth, but the first lateral tooth is quite similar to the rest, whereas in the Tritoniadæ it is different. The hermaphrodite gland is separate from the liver, as in *Bornella* and *Scyllæa*. The penis is unarmed as in the Tritoniadæ. *Bathydoris* appears to form a *remarkable connecting link between the Tritoniadæ and the Doridida*, with which latter group it agrees in possessing a *blood gland*.

Bathydoris abyssorum, n. sp. (Pl. XII. figs. 14–20; Pl. XIII. figs. 1–25; Pl. XIV. figs. 1–15).

Corpus quasi subgelatinosum, subpellucidum. Rhinophoria et tentacula brunnea, branchia et genitalia externa aurantiaca, podarium e nigro purpureum.

Habitat.—Pacific.

One specimen of this large species was taken in the middle of the Pacific, at Station 271, lat. 0° 33′ S., long. 151° 34′ W., from a depth of 2425 fathoms; bottom temperature, 1°·0 C.; bottom, globigerina ooze. The specimen was fairly well preserved in alcohol.

According to Mr. Murray's notes "the body of the *living animal* was gelatinous and

[1] Alder and Hancock, Notice of a Collection of Nudibranchiate Mollusca made in India, *Trans. Zool. Soc.*, vol. v. part 3, 1864, pp. 134–136, pl. xxxii. figs. 7–10.

[2] Bergh, Malacolog. Untersuch., *loc. cit.*, Heft vii., 1874, pp. 289–308.

transparent, the tentacles brown, the gills and protruding external generative organ orange, the foot dark purple."

The length of the specimen (somewhat contracted no doubt) is 12 cm., its breadth 10·5 cm., and height 7 cm.; the length of the foot 6·5 with a breadth of 4·5 cm.; the length of the tentacles and rhinophoria nearly 2 cm., and of the projecting glans penis 1·5 cm.; the height of the branchial tufts nearly 1·5 cm. The *colour* of the body, together with the branchia, a greenish-white, the rhinophoria greenish-grey, the head and tentacles brownish-grey, the projecting external genitalia yellowish-white; the quite narrow sides of the body and the foot black.

The body (Pl. XIII. fig. 1; Pl. XII. figs. 14, 15) is nearly spherical in shape, somewhat like a gigantic *Onchidiopsis;* there is no trace of a dorsal margin or distinct line dividing the back from the sides, but near the base of the foot all round the body the small elevated figures of the back were entirely absent; this region of the body is quite smooth, and passes anteriorly into the neck (fig. 14); it answers to the sides of the body in other Doridida. The *back*[1] is very convex, densely covered with small, scarcely elevated disk-like figures, each with a fine aperture surrounded by an areola with a raised margin; these figures are round or oval in form, the largest measuring 2·5 mm. in diameter; towards the periphery they decrease in size (figs. 14, 15); between them were a number of small papillæ, in height from ·5 to 2·5 mm., the former disks are no doubt the remains of other papillæ that have been lost (Pl. XII. fig. 16). At the anterior end are the *rhinophoria*, which were in this specimen fully extended, and the rhinophorial cavities reduced to a slightly prominent even margin; the stems of the rhinophoria (fig. 14, *a*,*a*) are strong and short, their club-shaped extremities elongated, with about 100 more or less complete narrow leaves on either side, the two series on the back side separated from each other by a dorsal prolongation of the stem. The flattened rather small *branchial tufts* are situated posteriorly, two on the right side and three on the left; probably the missing branchial tuft on the right hand side had been accidentally lost, since the remains of the stem (fig. 15) were visible. Each branchial tuft consists of four unequal tri- or quadripinnate leaves, which diverge from a common stalk; in the uppermost gill on the left side the stems bearing the small gill-leaves were separate, each bearing two leaves. Behind the last branchia, and completing in this way the branchial circle, is the *anal papilla*, situated in the middle line of the body, and directed backwards and downwards; the anal aperture is stellate (fig. 15). In front of the anus, close to the posterior right interbranchial space, is the prominent *renal papilla* (fig. 15). The *frontal margin* of the back is but slightly developed, and has no trace of appendages, and entirely disappears below (fig. 14). The *sides of the body* are very low. The *genital openings* are very conspicuous, and surrounded by a raised margin 11 mm. high (fig. 14); from the anterior

[1] There were two large lacerated holes on the back (2 cm. and 1·4 cm. in diameter respectively), through which a great part of the liver had been lost.

orifice projected the strong glans penis; through the posterior orifice opens the duct of the mucous gland, and the aperture was partly filled by the bifid fold of the duct. The *foot* (figs. 14, 15, *b*) is strong and broad, projecting about 10 mm. from the sides of the body; the anterior end of the foot is truncate, rounded in outline; it has a fine marginal furrow; the tail is short, about 1·5 cm. long.

The *central nervous system* is situated on the anterior part of the upper side of the bulbus pharyngeus; it is depressed and small; the length of the cerebro-pleural ganglia is about 7 mm. The *cerebral* ganglia (Pl. XIV. fig. 4, *a*,*a*) are broader anteriorly, and give off four nerves from the anterior border, one nerve running backwards from the external margin and two nerves from the upper surface, one of which is fine and delicate and the other stout and swollen into a ganglion at its base (ganglion opticum ?); no nerves appeared to take origin from the under surface. The *pleural* ganglia (fig. 4, *b*,*b*) are about equal in size to the cerebral; each is divided by a deep fissure into a smaller inner and larger outer portion; the latter alone gives rise to nerves—a thin delicate strand from the upper surface, and from the posterior margin four nerves, two of which are considerably stouter than the others; from the under surface spring three delicate nerves (fig. 4). The *pedal* ganglia (fig. 4, *c*) are hardly smaller than the cerebro-pleural, and oval in shape; the cerebro-pedal and pleuro-pedal connectives are separated by a distinct cleft (fig. 4); from the internal margin of the ganglion two nerves proceed, of which one was considerably stouter than the other; from the external margin four nerves arise, the anterior one being the stoutest; the *commissure* uniting the two pedal ganglia (fig. 4, *h*) springs from the postero-external margin of each, and shows an indistinct division into two or three bundles. The cerebro-buccal connective (fig. 4, *e*,*e*) is rather long; the *buccal ganglia* (Pl. XIII. fig. 2; Pl. XIV. fig. 4, *f*,*f*), situated upon the sides of the œsophagus, are large and oval, measuring about 4·25 mm. in length; each gives off four nerves, three posteriorly and one anteriorly; the commissure uniting the two (fig. 4, *g*) was unusually long (about 2·2 cm.), no trace of a gastro-œsophageal ganglion was detected. The nerve cells of the cerebral ganglia measured as much as ·28 mm.

I found no trace of eyes or otocysts.[1] The axial channel of the *rhinophoria* was wide and showing numerous variously sized apertures on the walls; the nervus olfactorius strong and somewhat swollen at the base of the club, forming a rudimentary olfactory ganglion (?); there were no spicules in the leaves of the club; the two retractor muscles of the rhinophorion were very strongly developed. The *skin* proper of the back is easily separable from the next layer, and shows a number of perforations, which correspond to the disks mentioned above, which are certainly merely

[1] Although after a careful examination I have not been able to detect eyes or otocysts, it is possible that both will be eventually found. On the "abyssal theory of light" there is no reason to doubt their presence. Eyes have been detected in a species of *Pleurotoma* dredged from a depth of 2090 fathoms, and in a *Fusus* from 1207 fathoms (Wyville Thomson, The Depths of the Sea, 1873, p. 465. K. Semper, Die natürl. Existenzb. d. Thiere. Bd. i., 1880, pp. 103, 262; Animal Life, Internat. Sci. Series, p. 420, 1881).

the scars left after the falling off of the papillæ, which during the life of the creature, no doubt, cover the whole of the back. The *papillæ* (Pl. XII. figs. 14, 15; Pl. XIV. figs. 1–3) consist of a layer of circular muscle bundles surrounding another perpendicular layer; transverse sections of the papillæ showed a number of apertures, corresponding to the vessels and nerves (fig. 3, *a*), which ramify in their interior, and are occasionally accompanied by a renal branch; on the surface of the papillæ are a number of small unicellular glands. The scars left after the removal of the papillæ display a somewhat yellowish double contour, the outer line corresponding to the circular, and the inner to the perpendicular muscular coat; the central orifice was yellowish, and contained the nerve. When the whole of this layer is removed, another appears which displays a branching network of nerves and ganglia (Pl. XIV. fig. 5), partly visible with a hand-lens, which gives off twigs to the papillæ; on the surface of this layer are a number of depressions answering to the perforations of the upper layer; beneath the nervous "rete" is a layer of muscular bundles crossing each other in all directions. The deepest layer, which follows the last-mentioned, is also provided on its surface with a nervous ramification, beneath which are longitudinal and transverse muscles. Beneath this comes the *peritoneum*, which is easily separable, and is in this region of the body milky-white in colour, owing to the presence of an irregular meshwork of the fine whitish renal tubules (Pl. XII. fig. 20). There were no spicules in the skin.

The *mouth tube* is strong and thick-walled, and about 1·5 cm. long.—The *bulbus pharyngeus* (Pl. XIII. figs. 2–6) is unusually large (5·8 cm. long, 5 cm. in height, and 4·2 cm. in breadth); the radula-sheath, situated on the posterior portion of its under surface (figs. 2, *c*, 6, *c*), is about 23 mm. long by 17 mm. broad and 7 mm. high. The organ is divided all around into two halves by a prominent rather sharp edge (the margin of the mandibles) (fig. 3); the anterior half is smaller and narrower, and comes to a point in front; the posterior half is rounded behind in the neighbourhood of the large radula-sheath; the upper surface dips downwards, in front somewhat obliquely, and is still more inclined posteriorly (Pl. XIII. fig. 2); close to the top is the origin of the œsophagus, and on each side of this are the openings, one on each side, of the salivary glands (fig. 2, *d*). The anterior part of the upper side is flattened, broader upwards, narrower downwards (fig. 3); the posterior part is broad and somewhat convex behind the pharynx (fig. 3). The anterior part of the sides of the bulbus pharyngeus forms an angle with the upper surface, and in the neighbourhood of the edge is depressed; along the edge the posterior portion shows a deep depression, elsewhere it is convex. The lower surface of the bulbus pharyngeus is convex, with a slight depression at the entrance of the arteria lingualis; the posterior part is broader, with a strong prominence on each side of the radula-sheath (fig. 2). The colour of the bulbus pharyngeus is a dirty yellowish-red, inclining to red on the under side and posterior extremity; the anterior half of the upper side is whitish, and has a nacreous appearance. Several strong *adductor*

muscles (fig. 2) pass forwards from the posterior part of the upper surface, and are attached to the labial disk. The *labial disk* is of oval form, about 2 cm. long (fig. 2, *a*, 3, *a*); each of the two halves of which it is composed measures about 7 mm. in diameter; it is whitish in colour; the inner edge is irregularly wrinkled; the mouth is a perpendicular slit, with bluish-black walls.—The upper commissure of the mouth having been divided in the middle line as far as the mandibles (fig. 6), the length of that portion of the bulbus lying in front of the mandibles was 2 cm. It was lined by a very thick (4·5 mm.) cuticle (fig. 6, *b*), which presented the usual finely striated and stratified structure, and was blackish in colour at the outside and at its somewhat attenuated fore-end passed into reddish-brown on the inside. The cuticle is firmly fixed along a part of the anterior end of the mandibles, over which it passes, to become continuous with the cuticle lining the deeper part of the buccal cavity, where it is again firmly fixed to the mandibles in the region corresponding to the insertion on the foreside (fig. 6). These mandibles appear with their free part, yellow-green in colour, at the bottom of the above-mentioned anterior part of the buccal cavity; the right mandible overlaps the left, a small portion only of which was therefore visible (fig. 4). On removing the cuticle from the strong muscular mass, the inner surface of the latter was visible, traversed by a series of longitudinal folds (which correspond to furrows on the cuticle). The muscular mass increases in thickness posteriorly; the flattened, concave, whitish, hinder extremity resting on the foreside of the mandibles; the diameter of this part was 13–14 mm. The mass is made up of an external circular and an internal longitudinal layer.—The *mandibles* are very large, about 4·4 cm. long by 2·8 cm. broad and 1·4 cm. high. The greater part is concealed within the bulbus, and is of an opaque, milky-yellow appearance, whitish in front and more yellow behind. The free portion is yellowish-green, darker on the backside, and covered with very fine radial striæ. In shape the mandibles are oval (figs. 4, 5), with an angle at the middle of the internal margin; the thickness (at the middle) is about 3 mm., gradually thinning towards the margins, and eventually being only ·4–·3 mm. in thickness. The upper and lower ends are rounded; the external margin is convex and thin, the internal straighter and rather thicker; about the middle it gives off a rounded tooth (fig. 5); the surfaces are smooth and finely striated concentrically and radially. On the lower part of each mandible is a thickened portion, forming a tubercle on both sides (fig. 5). The mandibles are not united by a hinge, although there exists a rudiment of this in the shape of a thickening on the upper part of the internal margin, but by the cuticle already mentioned which passes from one mandible to the other (fig. 4). Both sides of the enclosed portion of the mandibles are covered by a thick epithelium of thin cylindrical cells measuring ·08 mm. When the epithelium is removed, the colour of the mandibles is seen to be a fine canary-yellow, contrasting with the greenish colour of the free portion (of a breadth amounting to 10–12 mm.). The masticatory edge was worn, but did not appear ever to have possessed denticulations.—

The removal of the mandibles lays bare the *anterior portion of the muscular mass,* which bears the impress of their form. In the upper half the internal margin forms a thinner wing of about 3 mm. in breadth.—The walls of the hinder part of the buccal cavity, and the tongue for the most part, are reddish-brown, inclining to black; the tectum radulæ is black.—The *tongue* (fig. 6) entirely fills the hinder part of the buccal cavity, and is of the usual form, with a deep median cleft; the length of the tongue is about 2·6 cm., its breadth 3·5 cm., and its height 2·6 cm.; the *radula* is glittering blackish-brown, yellower within the sheath. The radula is made up of fifty-four or fifty-five series of teeth; further back there are sixteen fully developed and four not fully developed series; the total number is thus seventy-five; the radula and its continuation in the sheath have, when removed, an entire length of 4·5 cm., the breadth of the hinder part, when expanded, being 4·5 cm. The twenty anterior series of teeth were incomplete, specially on the median and outermost parts (Pl. XIII. figs. 23, 24); in the youngest series there were 128 to 130 on each side of the median tooth. The length of the youngest median plates is about ·5 mm. by a height of ·25 mm.; the height of the first lateral plate was about ·43 mm.; the length of the basal portion of the lateral plates increasing to ·8 mm. by ·58 mm. in height; the length of the nine outermost teeth was ·2, ·22, ·25, ·28, ·3, ·35 mm. up to ·4 mm.; the height of the outermost plate about ·35–·4 mm. The colour of the teeth is chitinous yellow, becoming darker at the basal portion; the teeth within the sheath much lighter in colour than the others. The *median tooth* has an elongate quadrangular basal portion, the middle of the posterior margin being more (Pl. XIII. figs. 7–9; Pl. XIV. fig. 6, *a*) or less (Pl. XIV. fig. 7) prominent; the anterior part of the tooth rises in an obliquely directed short strong hook, the posterior margin of which is somewhat excavated at the base. The first four or six *lateral plates* are rather broader than the rest, and have a shorter hook (Pl. XIII. figs. 10–15); the first (Pl. XIV. fig. 6, *b*) often has a median prominence (Pl. XIII. fig. 7*b*, *b*), just as in the median teeth. The teeth then gradually assume the normal form, but often show remarkable irregularities, especially in the breadth of the basal part (figs. 16, 17); the fourth or fifth is remarkable in this respect (fig. 13). All the following lateral teeth are of the same shape, with a rather narrow basal part (Pl. XII. fig. 19), and with the hook oblique, somewhat crooked pointed, and narrower in the back than the base (fig. 16). There are frequently irregularities, which sometimes take the form of a coalescence of two teeth (Pl. XIII. fig. 22); sometimes the hook is shorter than usual (fig. 16, *a*), or completely absent; occasionally (fig. 22) the back is deeply excavated. In the exterior sixth or seventh part of the series the size of the teeth gradually decreases (Pl. XII. fig. 19), mainly owing to the diminution in size of the hook, which in the outermost is quite rudimentary (Pl. XIV. figs. 9, 10).

The *salivary glands* are whitish and somewhat flattened, as far as could be made out, and rather short; the salivary ducts are strong, and about 10–12 mm. long (Pl. XIII. fig. 2, *d*).

The *œsophagus* (Pl. XIII. fig. 2, *e*) is short and wide, about 2 cm. long, the inside pro-

vided with numerous longitudinal folds (fig. 6), which are not continuous with those of the stomach. The *stomach*[1] is large, free, and consists of an anterior narrower and a posterior somewhat wider portion; the former is about 3·2 cm. long, by 2·4 cm. broad and 1·5 cm. high; the latter about 5·2 cm. long, by 4·5 cm. broad and 3 cm. in height; the former is reddish-grey on the outside, the latter greenish-grey with a nacreous lustre, it is provided with numerous muscular bands; the interior of nearly the whole organ is blackish-violet in colour, and has numerous strong longitudinal folds; the posterior end is smooth and greenish-grey in colour; at the posterior end above is the aperture of the bile duct. The wall of the stomach is 3–3·5 mm. thick, that of the intestine 2–5 mm. The *intestine* is strong and long (20 cm.); its diameter is everywhere about 10–12 mm.; it arises from the fore-end of the stomach, and takes the usual course to the anus; its interior is nearly smooth; with only a few folds which increase in thickness in the rectum.—The whole alimentary tract was completely empty, with the exception of the intestine, which contained a softish dark violet mass, made up of indistinguishable animal remains with a large (2·7 cm. long) pyriform body, possibly an animal allied to *Actinia*.

The *liver* was apparently about the same size as the stomach, and had a large cavity; the interior was of a brownish-black, the exterior of a dirty-grey, colour.

The *pericardium* is very large. The *atrium* of the *heart* broad and large; the ventricle has a length of 26 mm., a breadth of about 42 mm.; there is a thin-walled dilatation along its left margin; the *atrio-ventricular valves* are strong and about 4 mm. broad; the orifice of the aorta is unprovided with valves. The *blood glands* are of a yellowish-white colour, faintly tinged with green; they lie obliquely on each side of and above the pharynx, the left hand one being slightly in advance of the other; the left hand gland has a length of about 27 mm., with a breadth of 18 mm. and a thickness of 10 mm; the right hand gland a length of 35 mm., a breadth of 32 mm., and a thickness of 6 mm.

The *renal syrinx* is of a reddish-brown colour, pyriform in shape, and about 1 cm. long, with the usual folds on the inside; its pericardial orifice has a diameter of about 1·5 mm. The free part of the *ureter* is 4 cm. long, and is provided with folds and papillary outgrowths on the inside (Pl. XIII. fig. 25); that portion of the duct which lies within the body-wall, ending in the renal pore, is about 2 cm. long. On the peritoneum is a dense ramification of renal tubules (Pl. XII. fig. 20). On the surface of the liver there seemed to be a large and beautiful feather-like organ, which must be regarded as the kidney and the urinary chamber.

The *hermaphrodite gland* (Pl. XIV. fig. 11) was quite free, and lay, as it seemed, between the liver and the anterior genital mass, forming an irregular parallelogram-shaped organ, its length was 3·3 cm., with a breadth of 2·3–3 cm. and a height of about

[1] There were two large openings on the back, possibly produced by the distension on bringing the animal up to the surface from the great depth at which it lived. Unfortunately both the stomach and liver were here ruptured, and their connection broken, hence I am unable to make any positive statements concerning the relations of these organs and the exact situation of the hermaphrodite gland and renal chamber.

·8 cm.; the upper surface is covered by the reddish-grey peritoneum; the colour of the gland is yellowish-white, the surface granular; the larger granules are spermatic, the finer ones on their surface ovarian (fig. 12); the spermatozoa are of the ordinary form, the head measuring from ·009–·013 (fig. 13) mm., the minute ducts of the lobules are visible between the granules. From the inferior surface of the gland the strong hermaphrodite duct takes its origin (fig. 11).—The *anterior genital mass* is large, and measures 6 cm. in length by 5 cm. in height, and 3·5 cm. in thickness; the efferent ducts (2 or 3 cm.) prominent. The right side is very convex, thicker in front than behind; the inner (left) side flattened through contact with the bulbus pharyngeus, and somewhat hollowed out; the upper surface straight and rather flat; the under surface rather convex, but broader and flatter in front; the hinder end being more sloping and rounded. The hermaphrodite duct is about 4·5 cm. long, and, passing over to the hinder part of the anterior genital mass, forms a coil on the upper part of its right side about 4 cm. long; the diameter of the duct is about 3 mm., it continues its course to a short distance from the root of the large duct of the mucous gland, where it divides in the usual way. The *vas deferens*, issuing from the hermaphrodite duct, pursues a winding course to the præputium, where it forms a dense coil (Pl. XIV. fig. 14, *a*); when unrolled the duct measures about 7 cm. long by about 1·6 mm. in diameter. The *præputium* has a length of some 3·5 cm. with a uniform diameter of 2·2 cm., the thickness of its walls is about 1·5 to ·5 mm.; the cavity is almost filled by the large *glans* (Pl. XII. fig. 14, *c*), which has a length of 3·7 cm. and a breadth at its base of 1·9 cm.; in form it is conical, somewhat flattened on the under surface, where there is a long, wide, oblique cleft (Pl. XIV. figs. 14, 15), continued backwards into a wide cavity without any hole at the bottom; the continuation of the vas deferens, much coiled, could be followed along the whole of the upper side of the glans (fig. 15) into a small round opening at its point (figs. 14, *e*, 15, *c*); there was no trace of any armature of the glans or vas deferens. The glans is muscular, and contains large longitudinal vessels or lacunæ, especially developed towards the point, and a thick nerve. The cuticle on the cleft of the gland was colourless and quite smooth. The *spermatheca*, as far as could be made out, is roundish and flattened in form, of about 18 mm. diameter; it was quite empty and nearly concealed by the windings of the ampulla; its vaginal duct is no thicker than the vas deferens, and of about the same length as the organ itself. The *spermatocyst* lies beneath the windings of the hermaphrodite duct, and is whitish in colour, flattened, and of a rounded contour, 13 mm. in diameter; it was full of spermatozoa. The *mucous gland* is whitish in colour, with a tinge of green at its hinder part; the *albuminiparous gland* of a pale yellow; the *duct* of the mucous gland is about 3·5 cm. long and 1·7 cm. in diameter, the upper portion has (fig. 14) on its inner surface a number of longitudinal folds; the very strong, deeply furrowed fold (Pl. XII. fig. 14, *c*) is chalk-white.

Family Doriopsidæ.

This interesting Family, which has only been studied of late years, seems to be derived from the Doridida. In internal structure these animals are closely allied to the Phyllidiadæ, from which group, however, they differ greatly in external form, and have been united with them to form the group Porostomata.[1]

The Family consists of two genera—*Doriopsis* and *Doriopsilla*.[2]

Doriopsis, Pease.

Doriopsis, Pease, Proc. Zool. Soc. Lond., 1860, p. 32; Amer. Journ. Conchol., vol. vi., 1871, p. 299.
„ P., Bergh, Neue Nacktschnecken der Südsee, I. Journ. d. Mus. Godeffroy, Heft viii., 1875, pp. 82–94, Taf. x. figs. 21–23; Taf. xi. figs. 2–24.
„ P., Idem, Malacolog. Untersuch. (*in* Semper, Reisen im Archip. der Philipp. Th. II. Bd. ii.), Heft x., 1876, pp. 384–387; Supplementheft i., 1880, pp. 9–13.
„ Idem, Die Doriopsen des Atlant. Meeres., Jahrb. d. deutsch. Malacozool. Gesellsch., Bd. vi., 1879, pp. 42–64.
„ Idem, Die Doriopsen des Mittelmeeres, Jahrb. d. deutsch. Malacozool. Gesellsch., Bd. vii., 1880, pp. 297–328, Taf. 10, 11.
Doridopsis, Alder and Hancock, Trans. Zool. Soc. Lond., vol. v., part 3, 1864, pp. 124–130, pl. xxxi.
„ Idem, Trans. Linn. Soc. Lond., vol. xxv. part 2, 1865, pp. 189–207, pls. xv.–xx.
Haustellodoris, Pease, *loc. cit.*, 1871, p. 300.
Rhacodoris, Mörch, Journ. de Conchyl., ser. 3, t. iii., 1863, p. 34.
Hexabranchus, Gray (*nec* Ehrb.), Figs. of Mollusc. Anim. 1850, vol. iv. p. 164.

Corpus sat molle, forma fere omnino ut in Doridibus propriis. Apertura oralis poriformis; tentacula brevissima, affixa; rhinophoria et branchia ut in Doridibus propriis. Nothæum læve vel tuberculatum, limbo palliali ut plurimum latiori undulato. Podarium latum, ut in Doridibus propriis.

Bulbus pharyngeus elongatus suctorius mandibula et lingua destitutus.—Penis hamis seriatis armatus.

This genus was established by Pease in 1860, but its identity with the *Doridopsis* of Hancock was not made clear until the appearance in 1871 of another publication by Pease, where this author directly accentuated this identity. Hancock gave some account of the anatomy of this form, upon which I have myself contributed memoirs.

In external characters *Doriopsis* is very similar to *Doris*, but may be distinguished by its softer consistency and the undulated margin of the mantle; the mouth is a fine pore; the tentacles at the sides of the mouth are short and form a slight fold; the retractile rhinophoria and branchia are like those of *Doris;* the branchial leaves are tri- or quadri-

[1] Bergh, Malacolog. Untersuch., *loc. cit.*, Heft x., 1876, title page.

[2] Bergh, Die Doriopsen des Mittelmeeres, *Jahrb. d. deutsch. Malacozool. Gesellsch.*, Bd. vii., 1880, pp. 316–326.

pinnate; the foot is large as in *Doris*. In internal structure, however, this genus is widely removed from *Doris*, and resembles more closely the Phyllidiadæ. In the central nervous system the ganglia are very concentrated. The bulbus pharyngeus is elongated and tube-like, the buccal ganglia and salivary glands lying at its hinder end; there is no trace of mandibles or tongue, the bulbus itself forming a suctorial organ. There is a large inferior ptyaline gland.[1] In the pericardium is a special system of gill-leaves. There is a large sanguineous gland. The liver is deeply cleft at its posterior end (for the retractor branchiæ longus muscle). The hermaphrodite gland covers the liver; a spermatheca and spermatocyst are present; the end of the spermatic duct and the glans are armed with series of small hooks.

The genus is confined to the tropics, or at least the warmer seas; nothing is known of its habits and mode of life. The ribbon-shaped *spawn* of a few species has been detected, but nothing is known of their development.

The following is a list of the species that have been described:—

1. *Doriopsis nebulosa*, Pease.
   Pacific Ocean.

2. *Doriopsis scabra*, Pease.
   Pacific Ocean.

3. *Doriopsis viridis*, Pease.
   Pacific Ocean.

4. *Doriopsis affinis*, Bergh.
   Pacific Ocean.

5. *Doriopsis tristis*, Bergh.
   Philippine Sea.

6. *Doriopsis rubrolineata*, Pease.
   Pacific Ocean (Huaheine Islands).

7. *Doriopsis tuberculosa* (Quoy et Gaimard).
   Doris carbunculosa, Kelaart.
   Pacific and Indian Oceans.

8. *Doriopsis australis* (Angas).
   Pacific Ocean.

[1] With respect to the acidogene nature of the glandulæ ptyalinæ and salivales: see, Krukenberg, Vergl. physiolog. Studien, Bd. v. 1881, pp. 69–70.

9. *Doriopsis denisoni* (Angas).
Pacific Ocean.

10. *Doriopsis rubra* (Kelaart), Hancock.
Indian Ocean.

11. *Doriopsis fusca*, Alder and Hancock.
Indian Ocean.

12. *Doriopsis gemmacea*, Alder and Hancock.
Indian Ocean.

13. *Doriopsis pustulosa*, Alder and Hancock.
Indian Ocean.

14. *Doriopsis clavulata*, Alder and Hancock.
Indian Ocean.

15. *Doriopsis atromaculata*, Alder and Hancock.
Indian Ocean.

16. *Doriopsis punctata*, Alder and Hancock.
Indian Ocean.

17. *Doriopsis miniata*, Alder and Hancock.
Indian Ocean.

18. *Doriopsis nigra* (Stimpson), Hancock.
Indian Ocean.

19. *Doriopsis krebsii* (Mörch).
Doriopsis krebsii, var. *pallida*, Bergh.
West Indies.

20. *Doriopsis limbata* (Cuvier).
Doris inornata, Abraham.
Mediterranean.

21. *Doriopsis grandiflora* (Rapp).
Doris setigera, Rapp.
Doris rappii, Cantraine.
Mediterranean.

22. *Doriopsis gibbulosa*, Bergh.
Pacific (New Caledonia).

23. *Doriopsis nicobarica*, Bergh.
Indian Ocean.

24. *Doriopsis semperi*, Bergh.
Philippine Sea.

25. *Doriopsis modesta*, Bergh.
Philippine Sea.

26. *Doriopsis pellucida*, Bergh.
Philippine Sea.

27. *Doriopsis pudibunda*, Bergh.
Philippine Sea.

28. *Doriopsis maculigera*, Bergh.
Philippine Sea.

29. *Doriopsis albo-limbata* (Rüppell und Leuckart).
Red Sea.

30. *Doriopsis fumata* (Rüppell und Leuckart).
Red Sea.

31. *Doriopsis peruviana* (d'Orbigny).
East Pacific.

32. *Doriopsis fontainii* (d'Orbigny).
East Pacific.

33. *Doriopsis violacea* (Quoy et Gaimard).
Pacific Ocean (New Holland).

34. *Doriopsis fumosa* (Quoy et Gaimard).
Indian Ocean (Isle de France).

35. *Doriopsis debilis* (Pease).
Pacific Ocean (Huaheine Islands).

36. *Doriopsis compta* (Pease).
Pacific Ocean (Apaiang).

37. *Doriopsis sordida* (Pease).
Pacific Ocean (Tahiti).

38. *Doriopsis atropos*, Bergh.
West Atlantic (Rio Janeiro).

39. *Doriopsis grisea*, Bergh.
Pacific Ocean (Huaheine Islands).

40. *Doriopsis lacera* (Cuvier).
Doris wellingtonensis (Abraham).
Pacific Ocean (New Zealand).

41. *Doriopsis indacus*, Tapparone-Canefri.
Japanese Sea[1] (Yokohama).

42. *Doriopsis fuscescens* (Pease).
Pacific Ocean (Maiao Islands).

43. *Doriopsis australiensis*, Abraham.
Habitat ?

44. *Doriopsis obscura*, Abraham.
Habitat ?

45. *Doriopsis fumea*, Abraham.
Habitat ?

46. *Doriopsis fœdata*, Abraham.
Habitat ?

47. *Doriopsis subpellucida*, Abraham.
West Indies (St. Vincent).

48. *Doriopsis mammosa*, Abraham.
Habitat ?

[1] Zoologia del viaggio intorno al globo, &c., Malacologia, 1874, p. 114, Tav. i. fig. 16.

49. *Doriopsis variata*, Abraham.
Chinese Sea (Ning-pô).

50. *Doriopsis parva*, Abraham.
Habitat ?

51. *Doriopsis* (?) *punctata* (Rüppell und Leuckart).
Red Sea.

52. *Doriopsis* (?) *aurea* (Quoy et Gaimard).
Pacific Ocean.

53. *Doriopsis* (?) *nodulosa* (Angas).
Pacific Ocean.

54. *Doriopsis* (?) *carneola* (Angas).[1]

Doriopsis nebulosa, Pease (?) (Pl. IV. figs. 5, 6 ; Pl. V. figs. 28–31).

Doriopsis nebulosa, Bergh, Neue Nacktschnecken der Südsee, III. Journ. d. Mus. Godeffroy, Heft viii., 1875, p. 95, Taf. vii. fig. 5, Taf. xi. fig. 24 ;—IV., *loc. cit.*, Heft xiv., 1878, pp. 23, 24.

Habitat.—Sandwich Islands (Honoruru).

One specimen was taken on the Reefs of Honoruru ; it was preserved in alcohol, and was rather contracted. Its length was about 4 cm., with a breadth of 2·5 cm. and a height of 1·7 cm.; the breadth of the mantle edge was from 1 to 4 mm., behind about 9 mm.; the height of the retracted rhinophoria about 3·5 mm., and of the retracted branchia 5 mm., the diameter of the branchial cleft about 2·75 mm. ; the breadth of the foot 1·5 cm., the length of the tail 3·5 mm. The *colour* of the dorsal surface was of a bluish-grey, of the sides of the body yellowish-grey, with an indication of two or three longitudinal bands formed of series of spots ; the sole of the foot also was of a yellowish-grey; the branchia and *rhinophoria* bluish-black, the latter with a whitish terminal papilla.

The *form* of the body, as far as could be made out, is longish and stout ; the edge of the mantle undulating, and gradually increasing in breadth from before backwards, where it forms a kind of caudal veil ; its under surface is smooth. The dorsal surface is everywhere strongly wrinkled, and therefore is everywhere divided into variously-sized

[1] The Family Doriopsidæ contains the remarkable genus *Doriopsilla*, which differs from *Doriopsis* by its stiff body and hard granulated back, and also by the position of the buccal ganglia. But one species, *Doriopsilla areolata*, Bergh, from the Mediterranean, is known ; but perhaps *Doriopsis granulosa* of Pease is in reality a *Doriopsilla*. *Cf.* my Doriopsiden des Mittelmeeres, *loc. cit.*, 1880, pp. 316–326.

"islands," with the exception of the caudal veil; here and there are small, whitish, knob-like elevations, not exceeding 1 mm. in diameter. The club of the *rhinophoria* has on either side about thirty leaves and a strongly developed terminal papilla. The branchial *cleft* is transversely oval; the strongly retracted branchia is formed of eight tripinnate branchial leaves; the branchial circle is completed by the anal papilla (about 2·5 mm. high), whose opening is slightly prolonged downwards on the anterior side; at its base, a little to the right, is the *renal aperture*. The *mouth* is a fine pore, on either side of which is an inconspicuous knob-like *tentacle*. The foot is as usual.

The position of the intestines is as usual; the peritoneum is colourless.

The *central nervous system* is enclosed in the usual capsule, which is as usual attached by frenula to the region above and between the salivary glands.[1] The clear whitish-yellow ganglia form a thick ring, the upper half of which in the middle line is about double as long (from before backwards) as the lower half. The arched upper half of the ring appears beneath the lens to be very granular, the granules measuring about ·5 mm; it is broader behind, with a superficial median longitudinal furrow marking the boundary between the two halves; the under surface is smooth; the lateral portions pass into the smaller under half of the ring, which lies forwards; they are separated from it by a slight groove. The cerebral ganglia are long and larger than the pleural, which are situated outside their hinder part. From the *cerebral* ganglia arise the nervi orales; in front is the short-stalked ganglion olfactorium proximale, giving off the long winding nervus olfactorius, which at the base of the rhinophorion swells into a small round ganglion olfactorium distale, which gives off two nerves upwards; on its outer side is the short nervus opticus. The *pleural* ganglia give off the nervi palliales anteriores and the nervus pallialis longus; behind on the right ganglion, close to the pedal ganglion, I found another small ganglion (genitale?). The *pedal* ganglia are about as large as the pleural, they are plano-convex, thicker in front, where they are obliquely sloped; they are united by a short, broad, thin commissure (behind which is a narrower double commissure, composed of the sub-cerebral and pleural *commissures*); the ganglia give off three pedal nerves. The *buccal* ganglia are about as large as the proximal olfactory ganglia, and lie between, and a little in front of, the salivary glands, in contact with each other; at their outer part is a somewhat disconnected portion, which may represent gastro-œsophageal ganglia.[2]

The *eyes* are provided with black pigment and a yellow lens; the optic nerves are a little longer than the eyes, taking their origin from small optic ganglia a little larger than the eyes. The *otocysts* are a trifle larger than the eyes, containing a quantity of otoconia

[1] *Loc. cit.*, 1880, p. 301.

[2] I have also seen a similar appearance in *Doriopsis atropos*, *Doriopsis krebsii*, and *Doriopsis tristis*.

of the usual kind. Neither the leaves of the *rhinophoria* nor the skin contain any hard cells, and there are very few in the *interstitial connective tissue.*

The *buccal tube* is yellowish within; the outer surface being whitish, with fine blackish spots; it is 4 mm. long; the strong retractor muscles have many heads. The strong *buccal cone* ("Schlundkegel") is as long as the buccal tube, and fills it; it is yellowish; the opening at the summit as usual;[1] the interior of the buccal cone is also yellowish, with grey spots; the prolongation of the bulbus pharyngeus as usual only loosely fastened to the walls of the buccal cone. The *ptyaline* gland[2] is about 7 mm. broad, 2 mm. thick, and 4 mm. long; it lies beneath the anterior part of the bulbus pharyngeus, in front of the anterior genital mass; it is whitish in colour, and formed of two halves intimately united, and divided into many lobes by deep furrows. The efferent duct is formed of two chief branches, and is thick and coiled, it runs towards the buccal cone, becoming gradually thinner; when unrolled it measures 12 mm.; it runs as far as the end of the buccal cone. The *bulbus pharyngeus,* including the portion enclosed within the buccal cone, is 2 cm. long by ·5 mm., increasing to 1·3 mm. in thickness; yellowish-white and cylindrical, the lumen is arrow-shaped throughout the whole length. The whitish-yellow *œsophagus* is long, sausage-shaped, with numerous constrictions; it is 2 cm. long with an average diameter of 2·5 mm., which decreases in front to 1 mm., and behind to 1·5 mm.; the walls are thick; the interior has retiform folds. The connective tissue of its sheath is not pigmented. At the junction of the œsophagus and bulbus are the *salivary glands,* 1 mm. long by ·4 mm. in thickness, and faintly yellow coloured. The hinder end of the œsophagus is a little constricted, and then passes into the stomach, which is short, enclosed within the liver with the exception of the anterior end; the *stomach* is connected beneath with the wide cavity of the liver and above with the *intestine.* This latter projects somewhat just before the middle of the length of the liver and to the left, forming at its anterior end a short arch, and running in a groove upon its surface reaches the median line and mounts between the two heads of the retractor branchiæ muscle; its total length is 2·5 cm. and breadth 2–2·5 mm.; its inner wall has longitudinal folds.—The hinder visceral mass (*liver*) is 2·2 cm. long by 1·8 cm. broad and 1·4 cm. high; its somewhat excavated broad facetted anterior end is obliquely truncated from the left towards the right side and downwards and backwards; the hinder end is rounded, with a deep narrow cleft, through which the strong retractor muscle of the branchia passes; this cleft is continued on the under side of the liver into a median superficial furrow. On the surface of the liver in front there are on either side two or three deep perpendicular furrows. The colour of the liver outside as well as inside is greyish. The alimentary tract and cavity of the liver contained a mass of undeterminable animal remains.

[1] *Loc. cit.,* 1880, p. 304, Taf. i. fig. 1.

[2] *Cf.* Bergh, On the Nudibr. Gastr. Moll., I., *loc. cit.,* 1879, p. 143 (87).

The *pericardium* and the *pericardial gill* as usual. The yellow coloured chamber of the heart is 2·75 mm. long. The *blood gland* is greenish-grey coloured, about 7 mm. long by 4 mm. in breadth and ·2 mm. in thickness.—The *renal syrinx* is brownish-grey, melon-shaped of 3·5 mm diameter with strong internal folds. The urinary chamber as usual. The retractor longus branchiæ and the retractor papillæ analis[1] as usual.

The *hermaphrodite gland*, by its yellow colour, contrasting markedly with the grey liver, clothes the anterior end and the anterior half of the upper side of this organ with discrete or coalescent lobes; its structure is as usual; the gonoblasts being well developed.—The biconvex *anterior genital mass* about 6 mm. long by 10 mm. broad and 8 mm. in height; the efferent duct projects, moreover, 1·5 mm. The *ampulla* of the hermaphrodite duct (Pl. V. fig. 28, *a*) rests on the upper margin of the genital mass, and is yellow and pear-shaped, 5·5 mm. long (fig. 28, *b*). The male branch, which arises from the ampulla, runs on the upper margin of the brownish-yellow albuminiparous gland (fig. 28, *dd*), and is continued in the whitish-yellowish coloured *prostate* which descends on the anterior end of the genital mass; its total length is 13 mm. and its diameter 1 mm., it is cylindrical or slightly flattened, the upper surface not quite even, the walls thick, the axial cavity therefore rather narrow. From the lower end of the prostate the thin *seminal duct* takes its course to the genital papilla (fig. 28, *e*), in the last portion (·75 mm.) it is a trifle wider, and forms the penis (præputium) (fig. 28, *f*); the whole length of the seminal duct is 8 mm. At the base of the cavity of the yellow præputium is the truncated cylindrical glans, which is about ·25 mm. in length by ·08 mm. in breadth and ·03 mm. at its point. The glans (Pl. IV. figs. 5, 6) has 8–12–15 quincuncially arranged longitudinal rows of fine yellowish hooks, ·013 mm. high (Pl. V. figs. 30, 31); this part of the glans, where the hooks are developed, is not continued backward into the seminal duct proper (Pl. IV. fig. 5, *a*). The *spermatheca* is spherical, about 3·5 mm. in diameter (fig. 28, *g*), whitish in colour; its short duct bifurcates. The vaginal duct (fig. 28, *h*) is thin and quite as long as the vas deferens, behind it becomes a little wider and forms the *vagina* (fig. 28, *i*), whose length is about ·75 mm.; for about ·37 mm. of its length the vagina is lined by a fine brownish cuticle; this portion is about ·013 mm. in diameter, widening like a funnel behind and before (fig. 29, *aa*).[2] The uterine duct (fig. 28, *k*) is rather shorter, coiled, resting on the albuminiparous gland, and opens close to the female branch of the ampulla (fig. 28, *c*); just in front of its opening it receives the short duct of the spherical *spermatocyst* (fig. 28, *l*); this organ is whitish in colour and has a diameter of 2 mm.; it was filled with semen. The *mucous gland* is large, white and yellowish-white in colour; the albuminiparous gland is free at the upper margin and on the hinder

[1] *Loc. cit.*, 1880, p. 307.

[2] I have observed a similar condition in *Doriopsis tristis* (*op. cit.* III. *Journ. d. Mus. Godeffroy*, Heft viii., 1875. Taf. xi. fig. 5;—IV. Heft xiv., 1878, Taf. ii. fig. 17), and also in *Doriopsis debilis* (Malacolog. Untersuch., *loc cit.* Supplementheft i., 1880, p. 11, Taf. D. fig. 29).

side of the mucous gland, its colour is brownish-yellowish; the cavity was empty. On the upper side of its duct is the strong crescent-shaped white *vestibulo-vaginal gland*, 2·5 mm. in length and 1·3 mm. in height.

Whether this species is identical with *Doriopsis nebulosa*, previously described by me, or not, must be for the present left undecided; in external appearance at any rate it is very like *Doriopsis nebulosa*.

APPENDIX.

Family ONCHIDIADÆ.

Pulmonata (non testacea) doridiformia; limbo palliali plus minusve prominenti, recto vel undulato. Dorsum papillis vel tuberculis simplicibus vel compositis, interdum frutescentibus, ut plurimum pro parte ocelligeris obtectum; clypeus frontalis (subpallialis) fortis angulis tentaculiformibus, et postice rhinophoriis (ophthalmophoriis) exsertilibus cylindricis, juxta apicem ocelligeris. Pneumostoma posticum medianum vel submedianum infrapalliale; infra pneumostoma anus. Secundum totam longitudinem lateris (humilis) dextri corporis sulcus genitalis (femininus), juxta porum glandulæ pediacæ medianum, supra podarium antice situm, desinens; in parte postrema sulci vulva. Apertura genitalis masculina in facie superiore clypei frontalis submediana vel fere infra rhinophorium dextrum sita. Podarium latum.

Bulbus pharyngeus fere semper sine mandibula. Ventriculus compositus.

Vas deferens pro parte latere corporis inclusum, sulco genitali contiguum, deinde liberum, longissimum, ut plurimum ultima parte seriebus uncinorum armatum. Glandula cum ampulla et hasta amatoria ut plurimum non desunt.

The Onchidiadæ are specially modified shell-less Pulmonates, and resemble somewhat the Doridiadæ in outward form, and therefore were included in the Nudibranchiata by de Blainville. They resemble also the typical *Doris* in having a thick straight or sinuate *mantle-brim*. The *dorsal surface* is uneven, more or less densely covered with papillæ and tubercles, which are simple or compound; sometimes, especially in the hinder part of the body, they are frutescent (*Peronia*); these papillæ very usually bear groups of eyes, which have the structure of vertebrate eyes.[1] In front, below the mantle edge and above the mouth, is a strong, roof-like *frontal shield*; at the base of this and above

[1] Semper, Reisen im Archip. d. Philipp., Th. II. Bd. iii., Landmollusken, Ergänzungsheft, Ueber Sehorgane vom Typus der Wirbelthieraugen. m. 5 Taf., 1877.

on either side is the strong cylindrical *rhinophore* (ophthalmophore), which is exsertile, and bears an eye on its outer end; at the sides the frontal shield is prolonged into a tentacle. In the middle line, at the hinder end of the body, on the under surface of the mantle edge, generally at its base, is the *pneumostome*, the lung-aperture; below this, and above or at the root of the short tail is the *anus*. Along the right side of the body runs the *female genital furrow*, which is ciliated during the life of the creature; it commences in front of the anus, and is prolonged as far as the region of the opening of the so-called *foot gland*, which lies in the median line, above the anterior margin of the foot. At the hindermost extremity of this furrow lies the *female genital opening*; the *male* aperture is at the upper side of the frontal shield, nearer the middle line or below the right rhinophore. The *foot* is large and generally broad.

The *central nervous system* resembles that of other Pulmonates, as do the sense-organs; the remarkable dorsal visual organs, proper to this group, are formed on the type of the vertebrate eye.—The bulbus pharyngeus and tongue are like those of other Pulmonates; jaw-like organs are found only exceptionally (*Onchidium boreale*). There are three stomachs—an anterior, a masticatory, and a posterior (a kind of psalterium). The *liver* is also divided into three portions—an anterior (-upper), an inferior, and a posterior (-upper). The *intestine* is very long. The *lung cavity* is at the hinder end of the body, and extends to the right upwards; it opens nearly always in the median line, through the short respiratory tube with its aperture (pneumostome). On the walls of the lung cavity is the renal organ, which appears to open within it close to the respiratory tube.[1] The pericardium lies in the body-wall.—The hermaphrodite gland is made up of two halves, and is of the usual structure. The hermaphrodite duct forms only a very small or no special ampulla. The anterior genital mass (mucous and albuminiparous glands) is short and more or less rounded. The vesicula seminalis is large, roundish, and opens at the base of the duct of the mucous gland; this last duct opens within or at the hinder end of the female genital furrow. The vas deferens first takes its way along the mucous duct, and with it enters the side wall of the body, and then bends forward and becomes much thinner, and is enclosed within the body wall,[2]

[1] V. Jhering has, as is well known, divided the order Pulmonata (Vergl. Anat. d. Nervensyst. d. Moll., 1877, pp. 225–239, and Ueberdie system. Stell. von Peroniau. die Ordn. Nephropneusta, Jh., 1877) of Cuvier into two orders—the Nephropneusta (*Helicoidea*) and Branchiopneusta (*Limnoidea*). He agrees with Milne-Edwards (Leç. s. la phys. et l'anat. comp. t. ii., 1857, p. 91) in regarding the lung of the first-mentioned as morphologically the dilated termination of the renal organ (or cloaca) of the marine Ichnopoda; and the lung of the second group as the equivalent of a branchial cavity, from which the branchiæ have disappeared. Semper (Einige Bemerk. üb. die Nephropneusten v. Jhering's. *Arb. aus dem zool. zoot. Inst. in Würzb.*, Bd. iii., 1877, pp. 480–488) has brought forward considerable evidence against this, which has hardly been weakened by a later work of v. Jehring's (Ueber die system. Stellung von Peronia und die Nephropneusta, 1877, pp. 30–32).

[2] Other Pulmonata show the same course of the vas deferens. In *Veronicella* (*Vaginulus*) the condition is similar, but the part imbedded in the musculature is shorter, because the place where the vas deferens is imbedded in the skin lies, together with the vulva, about the middle of the side, and not at its end, as in *Onchidium*. A similar condition is also found in the Auriculacea and Lymnæacea, in which also a portion of the vas deferens, but much shorter than in *Onchidium*, is imbedded in the body-wall. *Cf.* Semper, *loc. cit.*, p. 251.

running along the genital furrow in its immediate neighbourhood towards the frontal shield, within which it forms an arch, and leaving it in the region below the right rhinophore, enters the body cavity; now this long free portion of the duct is somewhat thicker, and forms a coil in which the two parts, the prostatic and muscular, can often be easily recognised by their colour. To the last part of the vas deferens is attached a strong retractor muscle, and the vas deferens is then continued into the longer or shorter (when retracted) sac-shaped penis, which opens into the male genital cleft.[1] In most Onchidiadæ the last part of the vas deferens is lined with a strong cuticle, which, as in the Doriopsidæ, Phyllidiadæ, and other Nudibranchiata, has longitudinal rows of small hooks; the anterior portion of this last part can be everted. In many Onchidiadæ[2] there opens near the penis a very long coiled glandula hastatoria, which is prolonged in front into a spindle-shaped or sausage-formed ampulla, opening on to the male genital cleft at the side of the penis by its special duct and the straight long dart at its end.

Concerning the *development* of *Onchidium* not much was known until recently. Stoliczka observed that the young animals live massed together in deep earth-holes, and remarked that they perhaps had a direct development without larva. Semper[3] endeavoured, but in vain, to find the eggs. Joyeux Laffuie[4] finally succeeded in tracing the development of *Onchidium celticum*.

Onchidium appears to be *amphibious*, inasmuch as it is found on those parts of the shore where there is a regular ebb and flow.[5] According to Semper[6] the *function of the dorsal eyes* is to protect the animal from its (presumed) chief enemy, *Periophthalmus;* immediately it sees one of these approaching, it draws its body together and squeezes out a secretion from abundant cutaneous glands.

Onchidium is mainly an inhabitant of tropical or sub-tropical regions; from the Mediterranean only one species (*Onchidium parthenopeium*, d'Ch.) is known, and a very similar (*Onchidium celticum*, Cuv.; *Onchidium boreale*, Dall) from the northern part of the Atlantic. The different "species" agree very much in the outer form, and most of the species described by different authors will not be recognised with certainty. In recent times Semper has observed that certain parts of the genital apparatus afford useful systematic characters. The division of the Family into the genera *Onchidium*, *Peronia* (Blainville), and *Onchidella* (Gray) cannot be retained. Stoliczka[7] first clearly showed this. Semper[8] divides the Onchidiadæ into *Onchidium* proper and *Onchidella*

[1] Semper, *loc. cit.*, p. 254. [2] Semper, *loc. cit.*, p. 254. [3] Semper, *loc. cit.*, p. 488.

[4] Joyeux Laffuie, Organisation et développement de le l'Oncidie, *Oncidium celticum*, Cuv., *Archives de Zool. expér.*, t. x., 1882, pp. 1–159, pls. xiv.–xxii.

[5] Jhering, Ueber die system. Stell. von Peronia, 1877, pp. 9–15.—Joyeux Laffuie, *loc. cit.*, p. 237.

[6] *Loc. cit.*, pp. 30–32.

[7] Stoliczka, The Malacology of Lower Bengal, I., On the genus Onchidium, *Journ. of Asiat. Soc.*, vol. xxxviii. 2, 1869, pp. 100, 101.

[8] Semper, *loc. cit.*, Ergänzungsh., 1877, p. 40; Heft v., 1880, p. 254.

(which is not co-extensive with Gray's *Onchidella*); whether this generic distinction can really be made must be left doubtful for the present.

The Onchidiadæ unite the characters of the Steganobranchiata, the Nudibranchiata, and the Stylommatophorous Pulmonata. They are, like the first two groups, generally marine. In having a ciliated furrow on the right side, they resemble the Steganobranchiata. In the general form of the body they are not unlike *Doris*. The central nervous system closely resembles that of the Pulmonata; still, the pedal ganglia are separated, as in the Nudibranchs; and the retractors of the rhinophoria also resemble those of this latter group. They are, however, more especially *related to the Stylommatophorous Pulmonata*, like them possessing rhinophoria (Ophthalmophoria) and a foot gland. In spite of its modification, the nervous system is fundamentally similar, the gastro-œsophageal ganglia being also absent. They have also the uropulmonary system of the Pulmonata, and resemble them further in the structure of the genital system; a *spermatocyst* is *always absent*. The *blood gland*, so commonly present in the Doridida, is also *absent*.

With regard to the phylogenetic development of the Onchidiadæ, it seems likely that they have really nothing to do with the Nudibranchiata. A number of intermediate forms, however, connect them with the Pulmonata, and it seems more reasonable to suppose that they *descend from the Stylommatophorous Pulmonata* (Nephropneusta, v. Jhering), with which group they agree so closely in anatomical structure, and from which they do not deviate too much in development. They seem, in short, to be Pulmonata which have become adapted to an amphibious or marine life.[1]

Onchidium, Buchanan.

Onchidium melanopneumon, n. sp. (Pl. IV. figs. 25–27; Pl. V. figs. 1–27; Pl. VI. figs. 5–18, 20, 21).

Species *Onchidio tongano* magnopere affinis, colore dorsi obscuro (atro vel cæruleo-atro ?), pulmone aterrimo.

Habitat.—Pacific (Fiji Islands).

Only one specimen was taken in shallow water at Kandavu, in the Fiji Islands, August 1874, and was preserved in alcohol. The length of the animal was 6·5 cm., its breadth 4 cm., and its height 2·5 cm.; the breadth of the mantle edge about 1 cm., of the foot about 2·1 cm.; the free anterior margin of the foot projects about 4 mm., the tail is 6 mm. long, the head 17 mm. broad, the length of the rhinophoria 5 mm., the diam. of the pneumostome-papilla 5·5 mm.

[1] Brock, in his critical review of the memoir of J. Joyeux Laffuie (Biolog. Centralblatt., Bd. iii., 12, 1883, p. 370–374), regards the Onchidia as Nudibranchiata, allied to them by their organisation as well as by ontogeny. The Memoir of Dr. Brock did not come to hand before this sheet had been printed, but I still regard his opinion as erroneous.

The *colour* of the dorsal surface is bluish-black, the upper side of the head rather more brightly coloured; the upper surface of the rhinophore also of the same colour on account of the muscle shining through it, yellowish beneath. The whole under surface of the mantle edge and head, the sides of the body, and the foot also, are yellowish.

The *shape* of the body is as usual. The dorsal surface is covered with a number of rounded greyish simple or granulated tubercles (Pl. IV. fig. 25; Pl. V. fig. 2), measuring about 3·5 mm. in diameter, and 1–1·5 mm. high; among them are a number of smaller tubercles; towards the margin of the back these tubercles become smaller. The *eyes* were hardly distinguishable by a lens; in transverse sections of the skin they appeared to be scattered about singly or united in groups of three or four round a central papilla. The thick mantle edge is somewhat thinner, and sinuous in outline at the extreme edge; beneath it is smooth. The *frontal shield* (Pl. V. fig. 1) is strong and crescentic, somewhat crenate in the middle line, with rounded tentacular edges, at the base of which, above and laterally, are situated the nearly cylindrical rhinophoria (fig. 1), which bear at their summits the eyes, which were, however, invisible, the rhinophoria being not quite protruded. In front of the right tentacle at the upper side of the shield is the short slit-shaped *orifice of the penis*, about 2 mm. wide; at the base of the lower side the perpendicular mouth-slit with thick folded lips (fig. 1). At the hinder end of the body, at the under side of the mantle edge, is the *lung aperture* (pneumostome), even in its contracted state measuring about 1 mm. in internal diameter, surrounded by thick lips (Pl. V. fig. 2). On its inner side, at the base of the tail, is the *anal aperture*, the transverse diameter of which is 2·5 mm. (fig. 2). Near this last, on the right side, is a little papilla bearing the female *generative opening* (fig. 2). The papilla is continued into a long groove with two folds; this *genital groove* is prolonged along the low right side as far as the frontal shield, and is bent inwards at the root of the tentacle, and can be followed as far as the fine *pore of the foot gland* (situated behind the mouth), which lies deep in the space between the head and foot (Pl. VII. fig. 1, *b*). The *foot* is strong and broadest in the middle; the anterior portion is separated from the head by a space of about 4 mm.; it has a superficial marginal furrow (Pl. VII. fig. 1, *a*); the upper lip is slightly cleft in the middle line; the tail (Pl. V. fig. 2) is short and flattened, somewhat pointed, rounded at the end; the margins slightly (about 2 mm.) projecting.

The walls of the body, on the back as well as the foot, are (as much as 5 mm.) thick and leathery. The pseudo-peritoneum is quite colourless, the dissepiment behind the salivary glands only being slightly grey.

When the animal was opened, the organs of the body were seen to have the following relations to each other (Pl. V. fig. 27). At the anterior extremity is the mouth-tube (fig. 27, *a*) and the bulbus pharyngeus (*b*), then comes the œsophagus (*d*), directed obliquely backwards to the left, and on each side of it the yellowish-white salivary glands (*c*, *c*); after this comes the large dark greenish-grey anterior liver (*f*), bounded by

a loop of the intestine and traversed by the continuation of its right hand portion (*ee*); along the intestine on the left side is the sac-like ampulla of the glandula hastatoria (*h*). Behind the loop of the intestine and the anterior liver, is the dirty yellow-coloured masticatory stomach, of which the larger part of the left half is visible, with a whitish tendinous patch, and behind this the large dark greenish-grey hinder liver (*g*); on the right side of the liver and stomach lies the large whitish pericardium (*k*), fused with the wall of the body; on its inner side and covered by it is the large anterior genital mass (fig. 26, *b*), extending as far as the right hinder portion of the liver, and lapping the yellowish-white hermaphrodite gland, which fills (fig. 26, *a*) the hinder end of the body cavity. The hindermost end of the body is taken up by the black lung (fig. 27, *i*). Below the right salivary gland are visible the winding coils of the vas deferens, and further forward another portion of the same with the penis. Along the left side in a space are seen the coiled windings of the glandula hastatoria as a prolongation of its ampulla.—On the underside the situation of the viscera was as follows. Quite in front were the buccal tube and bulbus, then on the right the lower portion of the left salivary gland, and on its inner side the lower portion of the central nervous system; then follows on the right the ampulla of the glandula hastatoria and its coiled prolongation; on the inside of and behind this the radially striated third stomach; on the left side of which, and behind, is the under portion of the anterior liver. Further back, along its right margin, lies the hinder liver; on the inside of this, in front, is the transversely-placed anterior genital mass, behind which on the right, is the dirty-yellow vesicula seminalis, and on the left the yellowish hermaphrodite gland. The hinder end of the body finally is taken up by the black lung.

The central nervous system, which elsewhere in the genus *Onchidium* generally lies uncovered upon the upper side of the bulbus pharyngeus and the salivary glands, was in this specimen retracted, and surrounded the hinder part of the œsophagus, and was therefore (Pl. V. fig. 27) quite covered by the anterior liver. It did not quite agree with v. Jhering's[1] description of *Onchidium verruculatum*, Cuvier. It lay within a loose, but still adherent connective tissue capsule, which was prolonged some way along the roots of the nerves, and which could be only with difficulty separated from the ganglia. The ganglia themselves showed a greyish-brown colour. The central nervous system was, as usual, constructed of an upper and lower portion, both of which were considerably flattened. The *upper* portions—the *cerebral ganglia*—were of a rounded contour, and united by a strong commissure, about as broad as the diameter of the ganglion; each ganglion gave off the following nerves: the strong nervus tentacularis supplying the tentacle, and giving off the delicate nervus opticus; the nervus velaris, which divided into two branches; at least two nervi orales, two labiales, and several nervi bulbi pharyngei; finally a nervus genitalis externus to the penis, and the cerebro-buccal

[1] H. v. Jhering, Vergl. Anat. d. Nervensyst. d. Moll., 1877, pp. 230–232, Taf. iv. fig. 16.

connective.[1] The *lower* half was connected with the upper on either side by two connectives; it consisted of two pairs of ganglia lying upon each other, whose wide, broad commissure was about as long as the greatest diameter of the ganglia; they were separated by the strong arteria bulbi pharyngei. The (three?) *pleural ganglia* were somewhat smaller than the others, less flattened, and of transversely oval form; in front of their commissure was the thin sub-cerebral commissure. From each ganglion four nerves, partly united at the base, were given off to supply the side walls of the body and the back; one of these was especially thick, and extended backwards along the sides of the back. From each ganglion were given off two nerves, running along the sides of the posterior aorta as far as the anterior genital mass, giving off to it several branches, and finally reaching the hermaphrodite gland; from one of the left nerves a strong branch went to the region of the anterior bile duct. From the right side of the visceral commissure, near the ganglion, two nervi genitales arose, and were distributed to the vas deferens and the glandula hastatoria. The *pedal ganglia*, rather larger than the others, were of a rounded contour; they gave off a short nervus pediaeus anterior, a nervus pediaeus medius externus, and a nervus pediaeus posterior longus, which entered the sole of the foot about the middle of its length, dividing into a superficial and deep branch; from the latter arose numerous twigs directed obliquely inwards. A rope-ladder-like system, as first described by Semper[2] in opposition to v. Jhering[3] cannot, however, be dissected *in situ*. The *buccal ganglia* are of a rounded contour, and lie within a wide, but still rather adherent capsule united by a commissure (Pl. V. fig. 3, *b*), about double as long as the diameter of the ganglia; the two nerves going off from them supply the salivary glands, the œsophagus, and the hinder portion of the bulbus; upon them were ganglionic swellings; from the middle of the commissure a strong dichotomously branching nerve was given off, running backwards. *Sympathetic ganglia*[4] were found here and there upon the viscera; on the spot, where the arteria genitalis divides on the under surface of the anterior genital mass, there was a large white ganglion of oval contour and ·3 mm. diameter.[5]

The summit of the *rhinophore* was invaginated about 1·2 mm., and at the bottom of this depression was the *eye;* its greatest diameter was about ·28 mm.; the lens was yellowish, the pigment blackish-brown. The fine optic nerve was given off as a branch from the upper part of the rhinophorial nerve. At the base of the eye, enveloping it,

[1] It would be of high interest to examine whether the *Onchidia* possess the mouth-lobe-ganglion of the Pulmonata.

[2] *Loc. cit.*, p. 481.

[3] H. v. Jhering, Ueber die system. Stell. von Peronia, 1877, pp. 8, 9.

[4] According to Semper, *the buccal commissure* with its ganglia in the Gasteropoda represents the vagus of the Annelides. *Cf.* P. B. Sarasin, Entwicklungsgesch. d. Bithynia tentaculata, 1882, pp. 56, 57.

[5] Owing to the state of hardening of the central nervous system, it was impossible to investigate it fully. There appeared to be three pleural ganglia, of which the smaller right one and the median one were more nearly approximate.

is inserted the strong black-pigmented retractor magnus muscle; the other thinner retractors were similarly pigmented in the upper part. The rhinophorial nerve swells above into a small *rhinophorial ganglion*, which gives off several nerves, forming a network of branching fibrils, the *plexus gangliosus*, the ultimate fibrils of which end in the *olfactory epithelium* at the end of the rhinophore. The walls of the cavity of the rhinophoria were provided with some special thin nerves. I did not succeed in finding the *otocysts*,[1] owing to the strong pigmentation of the central nervous system. The *skin* (of the back) has an outer cuticle, underlying which is a thin single layer of cylindrical epithelial cells, among which were a number of variously-sized unicellular glands, with clear or granular contents. The peculiar dorsal eyes were present.[2]

The *buccal tube* (Pl. V. fig. 3) is strong, 6·5 mm. long, with a diameter at its hinder end of 8 mm.; in the middle line above are attached two lateral retractor muscles (figs. 3, 27), and just in front of them, running forwards, are a pair of protractors; on the underside two stronger retractors (fig. 3, *c*); the interior of the buccal tube has the usual longitudinal folds.—The strong *bulbus pharyngeus* (Pl. IV. fig. 26; Pl. V. fig. 3) is about 10 mm. long by 9·75 mm. in breadth and height; the strong radula-sheath also (Pl. IV. fig. 26, *a*; Pl. V. fig. 3, *d*) projects backwards about 3·5 mm.; the underside of the bulbus is flattened, the sides rounded, the upper side sloping at a considerable angle, both in front and behind; in front, on the under side, are a considerable number of protractor muscles. On opening the bulbus there were seen, on either side above the root of the tongue, a longish *palatal plate*, rounded at one end and more drawn out at the other (fig. 4, *b*, *b*), of a pale chitinous-yellow colour, and about 3 mm. in length by about 1·4 mm. in breadth. A closer examination showed these plates to be made up of a number of irregular borders and raised portions, generally prolonged into more or less worn-out teeth (figs. 5, 6); this whole chitinous layer was about ·2 mm. high. In the longitudinal and transverse furrows, also between these palatal plates here and there, instead of the ordinary cuticle, special similar thickenings were found (fig. 5). The fine terminal end of the palatal plates was continued as far as the opening of the pharynx (fig. 4). The *tongue* (Pl. V. fig. 4, *a*) was as usual, broad and strong, with a deep dorsal furrow; on the chitinous yellow radula there were forty-eight *rows of teeth* (counting by the outer edge of the radula), of which twenty-three were more or less incomplete, with a good many teeth worn; on the point of the tongue there were traces of two series that had dropped away. Further back, within the radula-sheath, there were forty-one developed and four not fully developed series; the total number was thus ninety-three. The total length of the

[1] In a small specimen of *Onchidium palaense*, S., measuring about 2·5 cm., from the Philippine Sea, I discovered the otocysts, visible as white points beneath the lens, in front of and above the pedal ganglia; their diameter was about ·12 mm., and they contained a large number of round and oval otoconia, measuring about ·007 mm. in diameter.

[2] Semper found among all the species of *Onchidium* which he investigated, only two, *Onchidium steindachneri* and *Onchidium reticulatum*, that did not possess dorsal eyes.

radula (separated from the tongue and the sheath) was 16·5 mm. by about 12 mm. in breadth. On the thirty-eighth row of the tongue there were 117 teeth on each side; on one of the youngest (the seventy-ninth) there were only 118. The *teeth* showed a clear yellow colour, generally darker on the thicker parts. The breadth of the median teeth (behind, on the tongue) was about ·07 mm., their length ·09–·11 mm.; the length of the hook of the innermost lateral tooth (behind, on the tongue) was about ·09 by ·08 in height, that of the six succeeding teeth ·16, ·18, ·2, ·22, ·235, ·25, and the length increasing to ·27 mm.; the height of the teeth from the sixth was ·18 mm. The length of the hook of the outermost tooth was about ·06 by ·044 mm. in height; the following ones ·068 mm. in length (by ·06 in height), ·08, ·1, ·1, ·11 mm. (by ·08 mm. in height), ·12, ·13, ·14 mm. (by ·01 mm. in height) and ·16 mm. The length of the cuticular thickening on the outside of the outermost plate was about ·025–·03 mm. The median teeth (Pl. IV. fig. 27, *a*; Pl. VI. fig. 5, *a*) are flattened and truncated at both ends, broader behind than in front; the anterior half thicker than the posterior, obliquely inclined in front, highest in the middle, forming a strong pointed hook, as also a denticle upon the lateral portions, which are directed obliquely inwards. The first *lateral tooth* (Pl. IV. fig. 27, *b,b*; Pl. V. figs. 7, *a*, 12, 13) is strong and clumsy, with a shorter base, which bears on the outer side a strong denticle; the hook much smaller than in the succeeding teeth. In the next following teeth (Pl. V. figs. 7, *b*, 8, 9, *a*, 10; Pl. VI. fig. 5) the base, but especially the hook, becomes gradually longer; in all the succeeding teeth (Pl. V. figs. 14, 16), which are the most numerous, they retain the same size, and in the outermost portion of the row—about the outer sixth—they again decrease (fig. 15). The body of the teeth (figs. 8–11) is strong and compressed; the longish basal part (*fig.* 16) is a trifle broader in front; in front and above on the outside of the body, close to the beginning of the hook, is a strong, obliquely flattened, pointed denticle (figs. 7, 8, 9, 10, 14); the inner side of the body is smooth (fig. 11). The hook is directed obliquely outwards and gradually bent (figs. 9, 10), its edges are smooth, and the end is more or less obliquely rounded off; the upper side is obliquely flattened, the under keel-shaped with a furrow along each margin (figs. 8, 10). The outermost tooth (figs. 14, *a*, 15, *a*, 19, *a*) is quite small with a short hook, but with a strong denticle on the outer side of the body. On the outer side of this last tooth I nearly always found one (fig. 14, *a*) or two (fig. 17, *a*) thickenings of the cuticle, thin, yellowish, and elongated.[1]

The *salivary glands* are pale yellowish-white, rounded, triangular masses, lying on the sides of the œsophagus (Pl. V. fig. 27, *c,c*), filling up the space between the bulbus pharyngeus and the anterior liver mass; the left gland is about 12 mm. long by 5·5 mm. in breadth, and of the same thickness; the right gland is smaller and broader, 8 mm. long, 13 mm. in breadth, and 5 mm. in thickness. In transverse sections their form is triangular; the outer surface (fig. 27) is convex and smooth, but divided into lobules by

[1] Hitherto there have been no accurate investigations into the mouth-organ of *Onchidium*.

small furrows; the inner and upper surface is smaller and fastened to the œsophagus; the inner, lower surface is large, and attached to the large ampulla of the glandula hastatoria. The salivary ducts (fig. 27) are rather short (3 mm. long) and open into the pharynx.

The *œsophagus* is strong and rather wide (Pl. V. fig. 27, *d*; Pl. VI. fig. 6, *b*), and passes obliquely to the left and then downwards; when fully extended it measures 3·5 cm., with a diameter of 4·5 mm. in the anterior part, and 1·5 mm. in the posterior; the interior has numerous folds, which are prolonged into the upper part of the stomach. The *first stomach* (Pl. VI. figs. 6, *e*, 7, *e*) is short and pear-shaped, about 11 mm. long by 9·5 mm. in diameter; it is yellowish in colour, with a thin wall not more than ·4 mm. thick, but with stronger circular bundles; the inside is covered with fine longitudinal folds, which usually bear very fine tubercles; the opening into the œsophagus and into the anterior (fig. 6, *c*) and inferior (fig. 6, *d*) hepatic duct, is round, with fine folds. The *second stomach* (figs. 6, *f*, 7, *f*; Pl. V. fig. 27) lies obliquely from above downwards and to the right; it is 15·5 mm. broad and about 7·5 mm. long in the middle, and at the ends 9 mm., with a thickness of 9 mm.; this masticatory stomach is somewhat compressed above, rounded and flattened, the lower end also rounded, the hinder end deeply cleft (Pl. VI. fig. 6); the median and largest portion of both flattened sides is occupied by a large tendinous patch, almost hour-glass shaped, of the ordinary bluish-white nacreous appearance; this stomach is marked off from the first stomach by a circular furrow, deeper above; a tendinous cord, broader at its two extremities, joins (fig. 6) the upper end of the second stomach with the third stomach. At the middle of the sides of the organ, where the tendinous patch is, the thickness of the wall is ·5 mm., at the ends they are (fig. 8) 6–6·5 mm. thick; in front the cavity of the masticatory stomach is connected with the first stomach by a wide oval aperture, the margin of which projects slightly into the interior of that first stomach; behind and above there is a small recess (fig. 8, *b*), which is prolonged and opens by a wide aperture into the posterior bile duct. The inside of the masticatory stomach behind (fig. 8, *b*) and in front (fig. 8, *a*) has longitudinal folds, but is smooth in the middle portion, on account of the thicker, somewhat uneven, yellowish cuticle. This cuticle was traversed by longitudinal furrows, and here and there by transverse furrows, which, by their intersection, mark off small longish, slightly-raised tubercles (Pl. V. fig. 23). When these thickened portions were cut through perpendicularly, the wall beneath this (·4 mm. thick) cuticula (Pl. VI. figs. 8, 9) and the epithelium attached to it, was seen to be composed of alternate layers of longitudinal and perpendicular muscle-fibres, which were easily separated from each other. On longitudinal section (fig. 8) they showed about six longitudinal bands, whitish, with a tendinous glitter,[1] which, however, do not reach from one end to the other; these longitudinal bands are composed of a number of longitudinally running fibres; they are separated from each other by short, perpendicular fibres of greyish-yellow colour. On trans-

[1] The above-mentioned small species (*Onchidium palaense*, S.) had a similar structure, and about the same number of bands (6).

verse section these last (fig. 9) appeared as yellowish-white longitudinally striated lamellæ, which at either end unite into a common muscular mass; between these lie greyish-white perpendicularly striated lamellæ, the same which in longitudinal section are tendinous-glittering white. The white hue of these lamellæ is the optical expression of sections which follow the direction of the lamellæ. The wall of the stomach consists in this way of layers of muscular fibres, which are made up of thin strands lying in close proximity; the layers alternate in direction, and are, therefore, quite different in longitudinal and transverse section. In the periphery of the organ the layers unite into a very thick, tight covering, which contains abundant blood-vessels (fig. 8). To the right hand and above in the first stomach (which may be regarded as an antechamber to the masticatory stomach) is the wide obliquely-oval orifice of the third stomach, the lamellæ of which are very conspicuous in the depth of the orifice; the hinder margin of the opening is more conspicuous, and projects in the form of a fold with transverse furrows. The *third*, the lamellated *stomach* (fig. 6, *h*) is united by a short neck with the first stomach; it is of a rounded angular contour, somewhat flattened, of about 11 mm. diameter by about 6 mm. in height; it is radially striped with a blackish colour, the folds of the inside are visible from the outside, especially at the margins. Besides the above-mentioned ligaments between this and the second stomach, there are also two strong bands on the upper surface, the exact relations of which could not be made out. The walls of the third stomach are not thick; the inside has numerous yellowish-white variously-sized folds passing from above downwards, which at the lower end reach a height of quite 3 mm. Generally a high fold alternates with several quite low ones; the largest folds are provided at the sides with smaller longitudinal folds directed upwards (Pl. V. figs. 21, 22). All the folds converge after the middle point of the stomach, and leave a fine central space. Below the folds are much lower in the opening of the stomach; above they gradually decrease in size as far as the intestine, where they end rather abruptly. The *intestine* (Pl. VI. fig. 6, *ik*) takes its rise at the upper end of the third stomach, and runs forwards for a short space (12 mm.), and then bends to the right, and ascending along the right side of the body, traverses a more or less superficial furrow upon the liver (Pl. V. fig. 27, *ee*), winding forwards and backwards; in the region of the middle of the pericardium it descends, bending backwards, and runs beneath the pericardium along the under side of the mucous gland, and approaching the middle of the body it takes its course between the foot and the lung-sac to the anal papilla (Pl. V. fig. 2). The length of the whole intestine is 14 cm. with an average breadth of 1·5–2·5 mm.; only the first extent of 6 mm. was somewhat broader, about 3·5 mm. in diameter, *widened into an ampulla*[1] (Pl. VI. fig. 6, *i*), showing on its outside a number of black pigmented lines. The inside of the intestine is yellowish-white in colour, and furnished throughout its entire length with fine longitudinal folds, which are a trifle higher in the ampulla, and

[1] This ampulla is regarded by Cuvier as a special stomach (Mém. sur l'Onchidie, p. 8, pl. figs. 5*y*, 7*y*).

separated by a smooth, narrow space from the stomach folds; these folds could be traced as far as the anal papilla (Pl. V. fig. 2).—The *alimentary canal* contained a quantity of whitish, rather hard matter, which was less abundant in the œsophagus and intestine; it consisted of calcareous matter and numerous littoral Algæ,[1] among which were species of *Calothrix* and *Percursaria* (*Enteromorpha*) *percursa*, Ag., mixed with the débris of a species of *Cladophora*.[2]

Of the three divisions of the *liver*, which were all of a dark greenish-grey colour, the *anterior* (Pl. V. fig. 27, *f*) was 16·5 mm. broad by 9 mm. in breadth and 10 mm. in height; its shape was concavo-convex, and it was traversed on its upper surface from the right margin by three deep furrows, reaching almost to the middle, and dividing it into four portions; further it was divided into lobes by numerous smaller superficial furrows; the intestine occupied a furrow on its upper surface; the anterior liver opens into the first stomach (Pl. VI. figs. 6, *c*, 7, *c*), to the left of and above the cardia. The *lower* and smallest liver mass, lying beneath the anterior stomach (Pl. VI. fig. 7, *d*), was only 13·5 mm. in length, by 14 mm. in breadth and 4·5 mm. in height; it is somewhat flattened in form, and traversed by superficial furrows, and opens by a short bile duct below the cardia into the anterior stomach (fig. 6, *d*). Finally the *hindermost* and largest liver, divided from the anterior by the masticatory stomach, has a length of 22 mm., a breadth of 15 mm., and a height of 8 mm. (Pl. V. fig. 27, *g*; Pl. VI. fig. 7, *g*); from the left margin two furrows run into the middle, and so divide the liver into three lobes; it opens into the recess behind the masticatory stomach (Pl. VI. figs. 6, *g*, 8, *b*). The *bile ducts* are short but wide; the undermost is the shortest (fig. 6, *d*); the hindermost is the longest (fig. 6, *g*, 8, *bc*), and is divided into three or four branches, which are again subdivided, and can be followed into the smallest lobes. On the main bile ducts were here and there smaller and larger liver lobes (Pl. VI. fig. 10); the walls of the chief bile ducts are strong and muscular, the inside provided with longitudinal folds with a thick epithelium.

The inner wall of the *pericardium* (Pl. V. fig. 27) is thinner in front than behind, where it passes directly into the walls of the lung cavity; the outer wall of the pericardium is thinner. The contracted yellowish-white ventricle of the *heart* was (flattened and) pear-shaped, about 7·5 mm. long; the atrium generally 12 mm. long; the atrio-ventricular valves (Pl. VI. fig. 11, *a*) are crescentic, with numerous thin habenæ musculares; the aortic valves were also conspicuous. The *truncus aortæ* (within the pericardium) (Pl. V. fig. 27) is strong, and is prolonged in front along the right side wall of the body, and there gives

[1] These species were determined by help of the Algologist, Kolderup-Rosenvinge.

[2] In *Onchidium palaense*, S., I found the contents of the digestive tract to be calcareous matter and sand, among which were many Polythalamia, and this seems generally to be the case in *Onchidium*. Cf. Semper, Einige Bemerkungen über die Nephropneusten v. Jherings, *Arb. aus dem Zool. Zoot. Inst. in Würzburg*, Bd. iii., 1877, p. 484, Note 1 ("Sie fressen wie die Holothurien nur Meeressand"). According to Joyeux Laffuie (*loc. cit.*, p. 14), the *Onchidium celticum* appears to live upon Algæ, especially Ulvæ, but it swallows a small quantity of sand to aid it in mastication.

off a strong gastro-hepatic artery above, which divides into several branches within the region of the cardia, for the supply of the stomach and the livers; the intestinal arteries and the posterior œsophageal artery are very strong. The main aorta is prolonged forwards to the region of the central nervous system, and then gives off the *aorta posterior*, accompanied on each side by two nerves; this enters the lower side of the anterior genital mass, then divides into numerous branches, and is prolonged backwards as the artery of the hermaphrodite gland. The anterior prolongation passes as the short *aorta anterior* between the pedal and pleural ganglia, and divides into (1) the pedal artery, which subdivides into an anterior and posterior branch which supply the foot, and into (2) the artery of the bulbus pharyngeus, which is prolonged forwards in the usual fashion, giving off the lingual artery, and a small branch to the foot gland.—The atrium of the heart receives the blood that has been arterialised in the lung by the *pulmonary veins*. The blood which enters the lung does so by means of the two *sinus laterales* (*circumpediaei*) and the *sinus pediaeus medianus*, into which the strong rete venosum of the foot empties itself; these large sinuses are in direct communication with the body cavity (by means of minute apertures in their walls), which forms a large *sinus venosus*, the two main divisions of this are united by fine pores in the septum lying between them.

The *lung* is of oval form (Pl. V. fig. 20), fastened above and on the outer side to the body-wall; the anterior wall passes into the pericardium. The length of the lung is 15·5 mm. by 10 mm. in breadth and 6 mm. in height; the outside is even. When opened the length of the cavity was 13 mm., the breadth 5·5 mm., and the height 5 mm.; the height and the breadth increased at the anterior and posterior extremities. The left wall and the left part of the lower wall of the cavity are smooth and yellowish in colour, and not covered by lung tissue. This latter covers the walls of the lung everywhere else (fig. 20), and is black; its free wall is spongy and reticulate; the structure of the lung appears to be precisely similar to that of other Pulmonata.[1] The *respiratory tube* (fig. 20, *a*) is short, about 4 mm. long, with fine longitudinal folds.

In the black lung tissue, and contrasting with it by its yellowish-white colour, is the *renal organ* (fig. 20), which measured 2·75 mm. in breadth. Its structure is as usual; the *urinary chamber*, which extends through the axis of the organ, is of rounded angular form and rather wide. I did not succeed in following the duct to an opening in the lung-cavity, nor did I find the renal syrinx, which certainly must have been present.[2]

The hindermost part of the visceral cavity is filled by a firm three-sided body, broader in front than behind (Pl. V. fig. 26, *a*; Pl. VI. fig. 12, *a*), which is 17·5 mm. long and 14·5 mm. broad by 11 mm. high. The anterior end was blunt and somewhat facetted; the hinder

[1] Semper, Beitr. zur Anat. und Phys. der Pulmonaten, *Zeitschr. f. wiss. Zool.*, Bd. viii., 1857, p. 370.

[2] Semper (*Arbeiten*, &c., Bd. iii., 1877, p. 485, Note) has observed the renal syrinx in *Helix* and *Vaginulus*. In a specimen of *Onchidium tumidum*, S., from Singapore, I found at the upper attachment of the atrium of the heart, enclosed in the spongy kidney tissue, a small organ with folds on the inside, covered with long cilia; this is certainly a *renal syrinx*.

end high, rounded; the upper side rather flat, with an impression of the upper side of the lung; the small right side is rounded with a longitudinal furrow beneath for the intestine (which in its last part runs over the vesicula seminalis); the larger left side is arched. The body consists of a smaller yellowish-brown hinder portion, the hermaphrodite gland, whose under margins embrace the greyish coloured seminal bladder; and a larger yellowish-white anterior portion, the mucous and albuminiparous glands (Pl. V. fig. 26, *b*; Pl. VI. fig. 12, *b*); both can be easily freed from each other. The *hermaphrodite gland* shows an arched upper surface traversed by fine furrows, but on the under surface there is a deep egg-shaped depression (for the seminal bladder); it is made up of two halves, nearly equal and not quite separated; in front and in the middle line, a portion of the yellowish-white hermaphrodite duct is visible upon its upper surface. The gland is as usual made up of a number of variously-sized lobes; the smallest lobes are pear-shaped (Pl. VI. fig. 13), with numerous ovarian follicles on the upper surface; there were no developed genital products. The short efferent ducts (fig. 13, *a*), which take their rise from these lobes, unite with each other to form thicker ducts; finally, there are two main ducts, forming a single duct, at the hilus of the gland, which runs over its upper surface with corkscrew-like windings, which when uncoiled have a length of 5·5 cm. with a diameter of ·6 mm. The duct opens behind on the under side of the anterior genital mass, near the albuminiparous gland.

The *anterior genital mass* (Pl. V. fig. 26, *b*; Pl. VI. fig. 12, *b*) is hardly half as large as the hermaphrodite gland; it is flattened on the upper side and arched on the lower side; the left half is larger than the right, and separated by a furrow, which is more conspicuous on the lower side. The left hand portion is more yellowish in colour; the right hand portion whitish, with finer windings (*albuminiparous gland*). The cavity of the mucous gland is narrow below, and passes into its narrow duct (fig. 12, *c*), which has fine longitudinal folds; the duct of the seminal bladder joins it at its base; it then becomes wider, its length being 15 mm., diameter ·9–1 mm.; it runs along the outside of the rectum as far as the body-wall, in which it then lies, and was followed with difficulty beneath the lung as far as the hinder portion of the (female) genital furrow to the vulva (Pl. V. fig. 2), this portion measuring 4 mm. in length. The outermost portion, the vagina, has fine longitudinal folds. The *seminal bladder* is spherical, about 10 mm. in diameter, of a dirty yellowish-grey colour,[1] and was filled with ochre-yellow débris; its duct is delicate and coiled, measuring when unrolled 15 mm. long.[2]—The end of the *hermaphrodite duct* behind, on the under surface of the anterior genital mass, bifurcates in the usual way at the albuminiparous gland; the *female branch* is short and opens near

[1] The anterior genital mass was so hardened that it was impossible to make out with certainty the relations of its constituent parts.

[2] Stoliczka (Malacology of Lower Bengal, I., On the genus Onchidium, *Journ. of Asiatic Soc.*, vol. xxxviii., part 2, 1869, p. 92) found the seminal bladder filled with a brownish-yellow mass, which contained bodies like sponge spicules, and others like the "peculiar arrows connected with the copulation of Helices." (??)

the albuminiparous gland; the male branch is continued in the *vas deferens*. This last is hardly thinner than the duct of the mucous gland, and accompanies it, being separated from it by a nerve cord, as far as its entrance into the side wall of the body; it could be traced in company with the vagina as far as the vulva, it then becomes thinner and bends forwards and runs in the outer lip of the female genital furrow as far as its anterior extremity (Pl. VI. fig. 12). In this long portion the vas deferens is firmly embedded in the substance of the lip, from which it cannot be freed; in transverse sections through the side walls of the body the vas deferens is seen within or near this same lip (compressed and perpendicularly oval) (Pl. VI. fig. 21, *c*), about ·25 mm. greatest diameter, with a very narrow cavity;[1] the course of the vas deferens along the body wall is (fig. 12) apparently quite straight. I could not follow it as far as the place where it appears to enter the frontal shield; within the last, but nearer the upper side, the vas deferens could be separated out, its course here is arched, the length of this portion being at least 4 mm. Beneath the right rhinophore, on the outer side of the common opening of the dart-gland and præputium (Pl. VI. fig. 12, *l*), the vas deferens is again free (it is of course only visible from the inside of the visceral cavity); for the first ·8 mm. of its length it is somewhat thinner (fig. 12, *d*), it afterwards becomes about double the thickness, changes in colour from white to brownish-yellow, becomes of a somewhat softer consistency, and forms a coil, brownish coloured behind (fig. 12, *e*) and more yellowish in front (fig. 12, *f*); the length of this coil is about 8 mm., and its diameter is 6 mm.; when unrolled, this, the *prostatic portion* of the seminal duct (fig. 14, *ee*), was fully 24 cm. in length and ·4–·5 mm. in diameter. Through the axis of the coil runs an artery, and a strong connective tissue strand, which anteriorly (fig. 14, *i*) is prolonged into a muscle going towards the penis-sac (fig. 14, *k*). Behind the *prostatic portion* is continued into the *muscular part* (fig. 14, *f*) of the vas deferens, which forms the hindermost portion of the coil, and when unrolled has a length of 4·5 cm. Shortly before the muscular part of the vas deferens leaves the anterior end of the coil (Pl. VI. fig. 14, *k*), the strong *retractor penis* muscle is attached to it, which takes its origin behind at several points from the body-wall, in the neighbourhood of the anterior end of the pericardium; it is greatly swollen in the middle, and thinner where it is attached to the vas deferens (fig. 14, *i*); from this point the vas deferens takes its course to the penis, being slightly thicker (fig. 14, *g*); this portion of the vas deferens is 14 mm. long. The *penis* is about 3·5 mm. long, and pear-shaped; it is connected laterally with the dart-gland by a transverse cleft (fig. 15). The præputium is rather thick-walled, the interior has numerous longitudinal furrows and fine transverse folds; the upper portion of the cavity of the præputium is nearly filled by the glans, which is about 1·4 mm. long, cylindrico-conical, and lined by a strong yellowish cuticle (figs. 16, 17). The *glans* had a round aperture, filled by a small cylindrical evagination, which was perforated

[1] Semper, *loc. cit.*, Landmollusken, Heft v., 1880, Taf. xxii. fig. 20 (*Onchidium glabrum*, S.).

at its extremity by a minute circular orifice (fig. 17); the evagination was the anterior end of that portion of the tube provided with hooks. This *hook-bearing part* of the seminal duct was ·2 mm. in length, its diameter in front being ·3 mm., and further back ·16 mm.; the hooks were arranged as usual in longitudinal quincuncial series (Pl. VII. fig. 4); the number in the rows was twenty to twenty-five hooks (twenty in the anterior row, twenty-two to twenty-five in the posterior). The colour of these *hooks* was a faint yellow, they were usually strongly bent; in the anterior part their length was ·04 mm. The papillæ upon which these hooks are formed are conical, broader at the base, and running into a point above, upright or bent. They are made up of small nucleated cells. I observed a very similar structure in the hooks of *Triboniophorus;*[1] Semper[2] also in *Onchidium.* But I do not understand why Semper speaks of this structure as "cartilaginous," and of the hooks as "cartilaginous teeth." There is no trace here of any real cartilaginous structure. The penis, as already mentioned, opens laterally into the large sac of the dart-gland. The *dart-gland* (Pl. VI. fig. 12, *h*) is long and thick-walled, and with its many coils covers a large portion of the ampulla developed at its end (fig. 12, *ii*). The whole *gland* can be easily unravelled, and then attains a length of 45 cm.; its diameter is about ·75 mm., the windings of the gland are connected by connective tissue. This connective tissue appears to start from a low irregular frill, which winds itself spirally round the ampulla and fuses with it. The gland has a roundish, rather wide lumen, lined with a thick epithelium, and its wall has nearly the same macroscopic and microscopic structure as the ampulla. The gland suddenly becomes wider at the *ampulla;* this last is sausage-shaped, somewhat arched, and at each end rather more slender, dirty yellow coloured; when extended it measures 2·8 cm. by 5·5 mm. in diameter. In transverse section the lumen of the ampulla appears triradiate (Pl. V. fig. 25), lined by the above-mentioned epithelium. Sections coloured with picric acid showed the parts nearest the lumen and to the periphery most coloured; the crenate triradiate lumen is embraced by a thick circular layer, which was interwoven and surrounded outside by a more or less continuous longitudinal layer of fibres; between the central and peripheral coloured layers are delicate rings and arches of tissue, composed of circular fibres imbedded in connective tissue; here and there, especially in the peripheral layers, were spaces for blood-vessels. In similarly prepared sections of the gland itself, the structure was precisely similar, only the thin middle layer was more strongly developed, and the lumina of vessels more abundant. The duct of the dart-gland, which takes its origin from the anterior part of the ampulla (Pl. VI. fig. 12, *k*), is about as thick as the gland, or a trifle thicker, and is half as long again as the ampulla, which it resembles in structure; in front it opens (fig. 12, *l*, 14, *ab*) into a sac-like somewhat flattened organ about 6 mm. long. At the

[1] R. Bergh, Anat. Untersuch. d. Triboniophorus schütteii, K., *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien,* Bd. xx., 1870, p. 853, Taf. xiii., figs. 7–9.

[2] Semper, *loc. cit.,* Landmollusken, Heft v., 1880, p. 253, &c., Taf. xxii. figs. 4, 12, 16, Taf. xxiii. figs. 3, 5, 6, &c.

hinder end (fig. 14*k*) of this the fascicles of a strong retractor muscle become broader and are fastened; this last has several points of origin, apparently united with the above-mentioned retractor, on the under side of the anterior portion of the prostatic coil of the *vas deferens;* the flat belly of the muscle gives off a strong branch, which is attached to the under side of the sac and the duct of the ampulla, and then divides,—the end of the *vas deferens* passing between its branches,—becoming attached to the upper and lower sides of the sac. A number of irregular fascicles arising from the body-wall were attached to the dart-sac, and to the penis (fig. 14, *a*), and served the purpose of protractors. The *dart-sac* is deeply cleft at the hinder end for about half its length. The right half forms a small special sac—the *penis* (figs. 14, *h*, 15, *b*), which by a slit-like opening communicates with the middle of the cavity of the larger sack (fig. 15). The larger left half, which forms the proper sac of the dart (figs. 14, *b*, 15, *d*), has a strong, muscular, but not specially thickened, wall; its cavity is nearly filled with the strong *dart-cone;* through the narrow cavity of this the outer prolongation of the efferent duct, somewhat narrower quite at the end, runs towards the slit-shaped orifice at the point; in the last fourth this outer part of the duct was attached to the wall of the dart-cone, otherwise it was free and accompanied by one or two nerves, an artery, and two thin muscle-slips. The surface of the dart-cone is covered by a simple epithelium; towards the apex are a number of unicellular glands. On the inside of the muscular wall (fig. 18, *c*) of the efferent duct the proper duct of the gland (fig. 18, *d*) is to be found, with its epithelium and thick cuticle, which latter passes in front into the nearly cylindrical, about 4 mm. long, brown-yellow coloured strong dart. This *dart* (fig. 18, *a*), together with the proper duct, can be easily removed from the cavity of the outer duct. It is straight, somewhat swollen (fig. 18, *b*) in the hinder fifth, being here of about ·43 mm. diameter, while the apex is not generally more than ·18 mm.; the opening at its point lies at the side, and is dilated behind into a slit (fig. 20); the wall of the dart is rather thin, thicker quite posteriorly; in the wall the branched bone corpuscle-like cells were rather inconspicuous.

I did not succeed in making out the structure and relations of the *foot gland.*

To compare with this species I have also investigated the following species, which is closely allied to it.

Onchidium tonganum, Quoy et Gaimard (Pl. VI. fig. 19; Pl. VII. figs. 1–6).

Onchidium tonganum, Quoy et Gaimard, Voyage de l'Astrolabe, Zool. Moll., t. ii., 1832, p. 210, pl. xv. figs. 17, 18.
" " Semper, Reisen im Archip. d. Philipp., Th. II. Bd. iii., Landmollusken, Heft v., 1880, pp. 258–260, Taf. xix. figs. 2, 9, Taf. xxii. figs. 1, 2, 10.

Habitat.—Pacific, Indian Ocean.

The specimen which I investigated was obtained by Professor Reinhardt during the

cruise of the Danish vessel "Galathea" in 1846, and was taken in Pulu-Milu, one of the Nicobar Islands, on the 7th November, on the shore. It belongs to the collection of the museum at Copenhagen, and was handed over to me for study by Prof. Steenstrup. The specific name was verified by Semper, who investigated all the specimens of *Onchidium* in the museum. It was well preserved in alcohol, but rather contracted.

Its length is 7·5 cm., breadth 5·8 cm., height 3 cm.; the breadth of the mantle edge is 18 mm., of the foot 28 mm., and of the frontal shield 20 mm.; the edge of the foot projects 4 mm. in front; the length of the tail is 2·5 mm.; the length of the rhinophoria 4·5 mm.; the diameter of the pneumostome 2 mm.; the anal papilla is 1·4 mm. in length; the breadth of the aperture of the penis, which lies a little to the right, is 2 mm.

The position of the viscera was quite as in the last species. The pseudo-peritoneum was colourless, but greyish-black beneath and at the sides.

The *central nervous system*, the *rhinophoria*, and the *eyes* resemble those of the last species. I did not find the *otocyst*. Semper has accurately described the *dorsal eyes*;[1] in the specimen examined by me there appeared to be only a small number of groups of eyes, and a small number of eyes in the groups.

The *buccal tube* was about 9 mm. long by 9·5 mm. in breadth. The *bulbus pharyngeus* as above, but the upper side more gradually arched; its length was 11 mm., height 10·5 mm., and breadth 10 mm.; the radula-sheath, moreover, projected behind 4 mm. I found the usual *palatal plates*, which were longer, narrower, paler coloured and less conspicuous; in structure hardly different, save that the denticles were mainly conical and longer (about ·28 mm. long). The *tongue* presented no differences; in the chestnut-brown coloured radula there were forty-three series of teeth; further back forty-two, of which the four hindermost were not fully developed; the total number was thus eighty-five. The eight anterior series were much worn, even their median teeth, and also the following series, but in a less degree. In the hindermost rows of the tongue there were 106 teeth (on either side), further back the number did not increase to more than 108. The shape of the teeth was hardly different from that of the last species.

The *salivary glands* were also similar; the left gland 12 mm. long, 8 mm. broad, and 2·5 mm. thick, somewhat bent, and traversed by furrows on both sides; otherwise fairly smooth, the margin lobate. The right gland is a little shorter and thicker, and rather more lobate.

The *œsophagus* resembles that of the previously described species; its length is 3 cm., and the diameter 3 mm. anteriorly and 1·5 mm. posteriorly. The *first stomach* is irregularly spherical, about 8 mm. long by 8·5 mm. in diameter; inner surface like that of the previously described species. The *second, masticatory stomach*, is 12 mm. long, 16 mm. broad, and 11 mm. in thickness; its form and the tendinous patches are like

[1] *Loc. cit.*, Landmollusken, Ergänzungsheft, 1877, p. 4, Taf. A. fig. 2; Taf. B. figs. 3, 4; Taf. C. fig. 9.—Heft v. 1880, p. 258.

those of the last described species; the thickness of the walls of the stomach is as much as 5 mm.; the cuticle and the thicker portions of the stomach as above, but less marked. The *third, lamellated stomach*, does not differ at all from that of the last species; it is in the same way radially pigmented, oval, and depressed in form; the greatest diameter 12 mm., the less 9 mm., the height only 4·5 mm.; the band mentioned above as lying between the second and third stomachs exists here also; the height of the leaves reaching about 3·5 mm.; their structure is precisely similar. Two of the folds of the third stomach are continued about 9 mm. into the intestine and then unite, the end hanging loose about 1 mm. from the wall; in this region of the intestine there is, moreover, a zone of short longitudinal folds. The *intestine* has a length of 15 cm. and a diameter of 2–2·5 mm.—The *cavity of the alimentary tract* was filled with a dirty yellowish-white mass, mainly consisting of littoral Algæ, calcareous matter, and Foraminifera; there were also pieces of the radula that had been torn off, even portions of teeth-series, often with as many as eight to twelve teeth.[1]

The most *anterior* of the three greenish-yellowish-grey *liver masses* measured 22 mm. in length by 19 mm. in breadth and 12 mm. in height; on its right margin were two deep obliquely running furrows which united anteriorly, and between them a shorter one; on the left margin was a single deep furrow. The *lower liver* was 22 mm. long by 8 mm. broad and 7 mm. thick, divided into four separate lobes by deep furrows. The *hinder liver* concavo-convex, 23 mm. long, 18 mm. broad, and 6 mm. thick, divided into six lobes by two deep furrows on the left and three on the right. The hepatic ducts and their apertures as in the former species.

The milk-white *pericardium* is precisely similar to that of the former species, the hinder portion imbedded in the lateral parts of the back; the anterior portion is freer and attached by short bands to the back and the right lateral wall of the foot. The pericardium is compressed, of oval contour, 24 mm. long by 14 mm. broad; the anterior portion occupying the first 17 mm. of its length, is thin-walled, and permits the heart to be seen within; the posterior portion shorter, and thicker behind, joins the wall of the lung. The *heart* is like that of the last species; the length of the contracted ventricle was 6·5 mm., the breadth (from above downwards) of the atrium is 14 mm. The *aorta* extends to the anterior end of the upper liver, between it and the intestine, where it gives off the strong gastro-hepatic artery upwards, and then, as usual, is continued forwards and backwards; branches of the anterior œsophageal artery supply the salivary glands.

The cavity of the *lung* is pretty wide, about 13·5 mm. long by 12 mm. in height and 8 mm. in breadth; the inner wall is thin but tough; in front it joins the hinder wall of the pericardium; the inner side, as well as the neighbouring portion of the lower wall of

[1] Semper (*loc. cit.*, Ergänzungsheft, p. 30) says that the *Onchidia* do not feed upon plants or animals, but take in only sand and mud. In nineteen species which he examined, Semper found "nothing but sand and mud."

the lung cavity, is smooth. Otherwise the walls of the cavity are thick, yellowish-grey coloured, spongy on the surface. Along its length the middle part of the right wall stands out somewhat, and is prolonged backwards, being traversed by the respiratory tube. In front, above and below, the wall for a certain space projects somewhat above the general level, and is here of a yellowish colour;[1] these parts, however, are only produced by the peripheral development of the *kidney*. On transverse sections being made through the thicker parts of the walls of the lung, the yellowish kidney is clearly visible in its interior with a roundish lumen; the cavity of the kidney could be followed beyond the pneumostome; the renal pore is said to be situated "behind the anus" (Semper),[2] but I did not succeed in discovering it; it seemed much more likely that the kidney opened by a cleft within the respiratory cavity, and thus into the lung. I was unable to detect a renal syrinx.

The *hermaphrodite gland* is about 10·5 mm. long by 15 mm. broad and 11 mm. high, of yellowish colour; it is made up of two equal halves, each of which is again composed of numerous smaller parts; in the lobes were large oogene cells and zoosperms. The *hermaphrodite duct* arises by two branches from the hilus of the gland, and is coiled in a cork-screw fashion; when unwound it measured 6 cm. long by ·8–1 mm. in diameter; it enters the hinder part of the anterior genital mass.—The *anterior genital mass* is 22 mm. long by 14·5 mm. high and 16 mm. broad; it is irregularly heart-shaped, flattened obliquely behind by the hermaphrodite gland; the right margin is convex and crenate, the left margin straight and flattened; the upper side is a good deal covered by the hinder liver, and is somewhat flattened; the under side is arched. This genital mass is made up of a larger yellowish part, which by a notch on the right margin is divided into two equal parts (*mucous gland*), and a smaller whitish portion (*albuminiparous gland*) which occupied the middle of the left half, especially on the under side. The female branch arising from the hermaphrodite duct opens near the albuminiparous gland. In the mucous duct, near its origin, opens the duct of the *seminal bladder*. This last lies behind and below the anterior genital mass, filling the apex of the visceral cavity; it is yellowish and of a somewhat flattened-spherical form, about 10 mm. in diameter, filled with detritus and fatty matter. The duct of the seminal bladder is rather thin and much coiled; when unrolled it measures at least twice as much as the bladder. The *mucous duct*, which runs along the outside of the rectum, is thin; for the first 8 mm. it runs obliquely backwards to the right side of the body, held in position by several obliquely crossing bundles; the duct, about 5 mm. in length, then passes further out, just under the lung, and extends as far as the vulva, which forms a small slit just (about 7 mm.) in front of the respiratory cavity, about the hinder end of the genital furrow; this vagina has folds on

[1] H. v. Jhering, Ueber die system. Stell. von Peronia, 1877, p. 18. He regards this last portion as an additional kidney, which only has a delicate covering of spongy (lung) tissue.

[2] Semper, Einige Bemerk. über die Nephropneusten, *loc. cit.*, p. 486.

the inside, with a thick epithelium; the diameter of the duct is about 0·5 mm. The *male branch* of the hermaphrodite duct is immediately continued into the *vas deferens*, which follows the same course as in the previous species; it accompanies the vagina and the duct of the mucous gland, and becomes imbedded in or near the outer lip of the "genital" furrow,[1] and is continued as far as its anterior end, where it apparently bends inwards, crosses through the frontal shield, and becomes again free on its inner side. The first 6 mm. of the vas deferens are delicate and whitish coloured; it then becomes about twice as thick and more yellowish coloured, and forms a coil which measured 11 mm. long by 5 mm. in diameter, and behind is of a rather clearer yellow colour; it then continues straight from the place of insertion of the retractor muscle (Pl. VII. fig. 3, *c*) for the space of about 6 mm. to the penis (fig. 3, *b*); when unravelled and extended the vas deferens measures some 20 cm.[2] by ·4 mm. in diameter; the difference in colour between the prostatic and muscular portions of the duct is not very conspicuous. The *penis* (Pl. VII. fig. 3, *a*) is short and sac-shaped, a little flattened, 4·5 mm. long by 2·5 mm. broad; its cavity opens laterally by a slit into the middle of the sac of the dart-gland. The præputium of the penis is like that of the previously described species; its cavity is clothed with a thick yellow cuticle and has strong transverse furrows, it is nearly filled by the short thick glans (fig. 3) with its cylindrical truncated prolongation, black on account of the hooks (fig. 3). This protrusible end of the vas deferens is 1·6 mm. long by ·35 mm. in diameter; the hooks are arranged as usual in longitudinal quincuncial series (fig. 4), about twelve or fifteen rows at the base of the protrusible part and fifteen to twenty at the point, and more backwards in the interior generally twenty-two to twenty-five; these hooks (fig. 4) were of the usual form, attaining a height of ·035–·045 mm., dirty yellow coloured, inclined to brown upon the base. The portion of the vas deferens armed with hooks does not extend backwards beyond the base of the penis; the whole length of this portion is not more than 6 mm. In the last straight portion of the vas deferens (fig. 3, *bb*) the proper seminal duct itself winds down in a cork-screw fashion, but goes straight in the other parts. The retractor muscle of the penis (fig. 3, *c*) is rather shorter than in the previous species,[3] at least 8 mm. long, and about the same breadth as the vas deferens throughout.—The *dart-gland* covers the largest part of its ampulla with its own windings; when unrolled it measured 51 cm. by ·8–1 mm. in diameter;[4] its structure is as above described. The *ampulla of the gland* has again the same form and structure; its length is 2·5 cm. and diameter 4·5 mm. The duct, which takes its rise from the anterior end of the ampulla, is coiled, when unrolled it measures 2·5 cm., and is hardly thicker than the gland. The strong *retractor sacci hastatorii* and the protrusors are quite as

[1] At the bottom of this furrow there was a fine longitudinal fold, whose sides were traversed by other folds; a similar condition was found by Semper (*loc. cit.*, Taf. xxii. fig. 20) in *Onchidium glabrum*.

[2] Semper (*loc. cit.*, p. 259) describes the length of this portion as being over 20 cm.

[3] According to Semper (*loc. cit.*, p. 259, Taf. xxii. fig. 10, *rp.*), the retractor muscle of the penis is much shorter.

[4] Semper (*loc. cit.*, p. 259), in a specimen measuring 5 cm., found the gland to have a length of 80 cm.

in the previous species. The *dart-sac* also is like that of the previous species; it is 6 mm. long by 3 mm. in diameter, its wall is not thick, the inside is covered with fine transverse furrows, the cuticle is thin; the cavity is filled by the short conical *dart-cone* (Pl. VII. fig. 5, *a*); the duct (fig. 5, *b*) of the gland, accompanied by two nerves (fig. 5, *d*) and several muscle-slips (fig. 5, *e*), could be followed to the depressed hinder end of the cone; the opening on the apex of the cone was a fine slit; the surface of the cone is covered by a low, beautiful large-celled epithelium. The opening on the apex of the cone leads into its cavity, whose walls are thicker and yellower in the outer portion; farther back the walls are thinner, on which account the enclosed *dart* (fig. 5, *c*) is dimly visible through; behind, the walls are continuous with the base of the dart, which is slightly moveable in the cavity. The *dart* (fig. 6, *ab*) has a whitish thick basal portion about 2 mm. long; the rest measures 4·25 mm. by ·37 mm. in diameter behind, and ·15 mm. at the apex, in other parts its diameter is about ·2 mm. It is straight and stiff, and brownish coloured; the lumen is circular, the walls thin; the opening on the apex is obliquely cut off (fig. 6, *a*), the margin at the side springs out as a short rounded projection, whence the aperture is of an oval form and generally varies in appearance according to the different positions (Pl. VI. fig. 19). The structures first observed by Semper[1] in this and other species in the form of branched cells like bone corpuscles, I have myself observed here (and in several other species) in the substance of the walls. These cells are here of a longish oval form, generally ·016–·020 mm. long, with a small nucleus; they are not frequently branched, but more generally simply drawn out at both ends; they are only found in the anterior half of the dart, and especially near its point. These cells have probably wandered into the chitinous tube during its development from the *membrane*, which clothes the *inner side of the chitinous tube* and is formed of small cells.

On carefully removing the intestines the whitish *foot gland*[2] (fig. 2, *b*) comes into view, about ·5 cm. behind the opening of the mouth-tube (fig. 2, *a*), in a slit behind the anterior ends of the two superficial pedal muscles, which here cross. Its length was 4 mm., breadth 2·5 mm., and height the same; it was a little egg-shaped (Pl. VII. fig. 1), higher in front than behind, with a longitudinal furrow along the sides, flattened on the under side, arched above. The duct (fig. 1, *b*) was about as long as the gland, wider in front than behind, and taking its origin from the anterior part of the gland; it had a funnel-shaped opening behind the end of the genital furrow. The wide cavity extended through the

[1] Semper, *loc. cit.*, pp. 260, 263, 264, Taf. xxii. figs. 1, 3, 13, Taf. xxiii. figs. 4, 11.

[2] In the genus *Triboniophorus* the foot gland extends much more into the body cavity (Keferstein, Ueber die zweitentakeligen Landschnecken, *Zeitschr. f. wiss. Zool.*, Bd. xv., 1864, p. 84, Taf. vi. fig. 4, *gp*,—and R. Bergh, Anat. Untersuch. d. Triboniophorus schütteii, K., *Verhandl. d. k. k. zool.-bot. Gesellsch. Wien*, Bd. xx., 1870, p. 850), also in *Limax pectinatus*, Selenka (Malacolog. Blätter, 1865, p. 107, Taf. ii. fig. 3, *gp*), in *Janella* (Keferstein, Ueber d. Anat. d. Janella bitentac., *Zeitschr. f. wiss. Zool.*, Bd. xv., 1865, p. 449, Taf. xxxiv. fig. 3, *gp*), and partly in *Limax marginatus*, Drp. (*Zeitschr. f. wiss. Zool.*, Bd. viii., 1857, p. 351 (Semper)); in *Philomycus*, on the other hand, and certain species of *Onchidium* (*Onchidium tumidum*, S.), the gland is enclosed in the foot (R. Bergh, *loc. cit.*, pp. 860, 865), or partly free (Keferstein, Zur Anat. von Philomycus carolinensis, *Zeitschr. f. wiss. Zool.*, Bd. xvi., 1866, p. 187, Taf. ix. fig. 2, *gp*).

entire length of the gland, the lateral walls especially projecting along the middle of the length; the walls of the cavity were somewhat spongy; the gland follicles appeared to be quite like those of other species. The walls of the efferent duct had fine longitudinal folds. This gland is perhaps in some way connected with the genital function, perhaps oviposition.

For comparison I further examined the following species.

Onchidium verruculatum, Cuvier (Pl. VII. figs. 7–12; Pl. VIII. fig. 14).

Onchidium verruculatum, Cuvier, Règne Animal, 2me éd., t. iii., 1830, p. 46 (footnote[1]).
„ „ Semper, *loc. cit.*, pp. 255–257, Taf. xxi. fig. 1; Taf. xxii., figs. 3, 4.

Habitat.—Indian Ocean.

I investigated a single specimen of this species, which was taken during the "Galathea" Expedition, by Prof. Reinhardt, in February 1846, on the north shore of Sambelong (Great Nicobar), in the Ganges Harbour. The specimen had been determined by Semper.

The specimen had been well preserved in alcohol, and was only slightly contracted; it was 3·3 cm. in length, 2·3 cm. in breadth, and 1·1 cm. in height; the breadth of the mantle edge 4·5 mm., of the foot 18 mm., of the head 15 mm.; the length of the rhinophoria 3 mm.; the free anterior edge of the foot projects 2 mm.; the length of the tail is 2·5 mm., the width of the pneumostome 2 mm.

The pseudo-peritoneum is black in colour, its diaphragm greyish. The position of the organs of the body was quite as in the previous species.

The *central nervous system*[2] as above; the pleural ganglia were, however, relatively larger than in the specimens previously investigated. The *dorsal eyes* (Pl. VIII. fig. 14) which have been accurately described by Semper,[3] were present in small numbers; I counted about twenty groups of eyes, each containing from three to four; their structure was as described by Semper. The *rhinophoria* and the *eyes* situated upon them as usual; the cavity of the former was entirely free from pigment. I did not succeed in discovering the *otocysts*.

[1] In the second édition of the Règne Animal, Cuvier named the *Onchidium*, figured in the Déscription de l'Égypte, *Onchidium verruculatum*. This name was first adopted by Keferstein (Einige Bemerk. über d. Geschlechtsorg. von Peronia verruculata, Cuvier. *Zeitschr. f. wiss. Zool.*, Bd. xv., 1864, p. 91) for individuals from Java and Japan. But this identification appeared probable first through the comparative researches of Semper (*loc. cit.*, 1880, p. 256), who had investigated a number of individuals from the Red Sea to beyond the middle of the Pacific of this widely distributed species.

[2] The nervous system is treated of by v. Jhering (*loc. cit.*, p. 230, Taf. iv. fig. 16).

[3] *Loc. cit.*, Landmollusken. Ergänzungsheft, 1877, p. 4, Taf. A. fig. 5; Taf. B. figs. 1, 2;—Heft v., 1880, pp. 255–256.

The *buccal tube* is 4·5 mm. long, the interior as usual; the protrusor muscles are covered at their origin with a pigmented sheath. The *bulbus pharyngeus* about 6 mm. long, 5·5 mm. broad, and 3·5 mm. high; the large radula-sheath (with the dark prolongation of the radula) only projects slightly. The *palatal plates*, and their denticles, quite as strongly developed as in the former species. The *tongue* is as usual; in the dark amber-coloured glittering radula there were thirty-three series of teeth (counted along the outer margin); further back there were thirty-one series, of which four were incompletely developed; the total number is thus sixty-four. The fifteen or sixteen anterior rows were more or less incomplete,[1] and the teeth themselves frequently worn out; in the hindermost rows of the tongue there were eighty teeth on each side, and the number appeared not to increase notably further back.[2] The *teeth* in colour and shape were quite like those of other species; the median teeth (Pl. VII. fig. 9, *a*,*a*) perhaps a little longer and broader behind.

The *salivary glands* are of nearly equal size, yellowish-white and of irregularly oval form, 6 mm. at their greatest diameter, by 3·75 mm. to 4 mm. in length, and 2 mm. to 2·5 mm. in thickness; the outer surface smooth and convex, the inner very uneven. The gland is made up of a number of variously sized lobules united (fig. 10). The duct has an outer pigmented sheath, it is 3 mm. long.

The *œsophagus* forms a short ampulla, 1·6 mm. broad, just behind the pharynx, pigmented black on the outside, the folds of the interior were stronger here than elsewhere; the whole length of the œsophagus is about 13 mm., and its diameter 1 mm. to 1·3 mm. The *first stomach* is pear-shaped, its length and diameter being about 4·3 mm. The *masticatory stomach* is of the usual form and appearance; its breadth is 9·5 mm. with a length of 7 mm. and a height of 5·5 mm.; the thickness of the walls reaches 4·2 mm.; the structure is quite similar to that of the previous species, and even more easy to see; the band between it and the third stomach is quite as usual. The *third stomach* is strongly pigmented (black) on the left and upper sides, and somewhat depressed; its greatest diameter about 7 mm., its least 3 mm.; the lamellated structure as usual, the height of the leaves reaches to 2·2 mm., the number of the largest and medium sized leaves is about thirty, between them are moreover a number of small ones; two of these leaves fused together are also seen continued into the intestine. The *intestine* had a length of about 9·5 cm. by a breadth of 1·8 mm. to 1·2 mm.—The contents of the alimentary tract were littoral Algæ, sand, and calcareous mud, portions of sponges, Diatomaceæ, and Polythalamia; frequently there were to be found teeth of the radula of the animal itself.

The *livers* had a dirty greyish-yellow colour, the upper surface covered with white points.[3] The anterior liver is about 11 mm. long by 7·5 mm. broad and 4 mm. in

[1] The anterior row was reduced to a median and one lateral plate, the following series to :—5–1–7, 7–1–5 . . . 4 . . 3, 26–1–30, and so on.

[2] Semper (*loc. cit.*, p. 257) describes 131 teeth in each properly developed row.

[3] The white points were possibly the eggs of some parasite.

height; it is very lobate, the number of the larger lobes being about six. The lower liver is 10 mm. long by 5 mm. broad and 3 mm. in thickness, the number of the larger lobes being here three. The hindermost liver is 7 mm. long by 6·75 mm. in breadth and about 2·5 mm. in height; it is, like the others, markedly lobate. The structure is quite as usual; the hepatic ducts open in the usual way.

The *pericardium* on the inside is, like the visceral cavity, strongly pigmented; its contour is oval, and the length about 8 mm. The *heart* is as usual; the gastro-hepatic artery is very stout, and extends along the under surface of the stomach, giving off a special branch to each stomach, and to each of the liver masses.

The *lung cavity* is rather narrower than in the preceding species, and about 6 mm. long; its brownish-grey walls are of the usual structure; the respiratory tube is 3·5 mm. long, with longitudinal folds. The *kidney* contrasts with the lung cavity by its whitish colour.

The *hermaphrodite gland* is pale brownish-yellow, and consists of two imperfectly-separated halves. The spermatozoa attain a length of ·4 mm., the head alone ·013 mm. long. The duct is formed of two chief branches, and projects from the hilus of the gland; these branches are each subdivided into two or three twigs; the common hermaphrodite duct is long and spirally wound; when fully stretched the length is 2·5 cm., and the diameter ·5–·7 mm.—The *anterior genital mass* has the form of a short truncated pyramid, with the base directed upwards and anteriorly; its length is 9·5 mm., the breadth of the base 9 mm., and the height 8 mm.; the hinder end of the mass is formed by the seminal bladder. The duct of the mucous gland was followed as far as the vulva (fig. 7, *c*); the *spermatheca* is as usual, its duct slightly longer than the organ itself. The *vas deferens*, running along the vagina, could be traced as far as the outer lip of the genital furrow, considerably thinner than the vagina; the course of the vas deferens along the genital furrow as in the previous species. It is colourless as far as its entrance into the body cavity (beneath the right rhinophore), and was followed in its way through the frontal shield; it then becomes black in colour, and a little thicker for about 1 mm. in length, and then increases about four times in thickness, and forms a coil, blackish-brown in colour, which, when unrolled, measured 5·5 cm. and ·3 mm. in diameter; this coil then passes into another, smaller, more longish and whitish in colour, which measured 5 cm. The thickness of this last *muscular* portion of the vas deferens is a little less than that of the *prostatic part*; the last portion of the muscular part is straight, and measures 1 cm. in length, and is about half as thick as the rest of this part. The *penis*, as already stated by Semper,[1] is of unusual length—5 mm.; it is cylindrico-conical in shape, and measures behind ·75 mm. in diameter and 2 mm. in front; its cavity opens into the male genital cleft, close to the dart-sac. The præputium is thick-walled, with strong transverse furrows on the inside; at the base of its cavity is the opening of the vas deferens, the anterior part of this was

[1] *Loc. cit.*, p. 259.

evaginated as a low papilla armed with hooks. The whole armed portion of the vas deferens was about 3 mm. long, by about ·08 in diameter, increasing to ·1 mm. on the point. The number of the longitudinal rows of hooks towards the point was twenty-five, arranged quincuncially; farther back there were twelve to fifteen;[1] in a single row I counted about 170 hooks. The *hooks* are yellow coloured, slightly bent, the hindermost being ·02 mm. long;[2] their form and structure as usual. The retractor muscle of the penis is much as usual, but rather longer, as Semper[3] has already stated. The *dart-gland* is a large yellowish coil of about 4 mm. in diameter; unrolled, its length was 10 cm. by about ·5 mm. in breadth; its lumen and structure are as usual. The gland gradually passes into the *ampulla*, which was of an elongated spindle shape, and measured 7 mm. in length by ·8 mm. in diameter; its very narrow cavity is roundish in section, the structure being as usual. The *duct* of this gland is a little longer than the ampulla, and a little thicker than the gland, with strong walls (fig. 11, *d*). The *dart-sac* is elongated-conical, slightly bent, and 7·5 mm. long, with a diameter of ·9 mm. posteriorly, and 2 mm. in front; its anterior end, like the anterior margin of the præputium, is black. The inside of the thick walls shows strong transverse folds above, and slight longitudinal ones beneath; behind, quite at the base of the sac, is the depressed *dart-cone* (fig. 11, *a*), in the cavity of which is the *dart* (fig. 11, *b*), the darker basal portion of which (fig. 11, *c*) is visible through the walls of the sac. The dart[4] is straight, pale yellowish in colour, dirty brownish-yellow at the root; its length is 1·76 mm., and diameter ·03 mm. at the apex, ·16 mm. at the base; the aperture (fig. 12, *a*) at the apex is in form nearly like that of the previous species—circular; the walls of the dart contain the usual cells, especially towards the apex (fig. 12), where they are also larger. The retractor and protrusor muscles of the dart-sac are as usual.

About half (1 mm.), of the white *foot gland* (fig. 8, *b*) projected freely in the middle line; the gland is somewhat more flattened than in the previous species, the cavity extends through the entire length of the gland; the duct is generally as long as the gland itself, and opens by a narrow slit; just in front of the opening is the end of the genital furrow.

[1] Semper (*loc. cit.*, p. 257) gives the number of "cartilaginous teeth' in the "rings" as twenty or more in front.
[2] According to Semper (*loc. cit.*, p. 257) the height is ·02 to ·07.
[3] *Loc. cit.*, p. 259.
[4] Semper has already (*loc. cit.*, Taf. xxii, fig. 3) figured the dart.

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PLATE I.

PLATE I..

Figs. 1–12. *Archidoris kerguelenensis*, Bergh.

Fig. 1. Central nervous system, from above; *a, a*, pedal ganglia at the outer side of cerebro-pleural ganglia, near to them are the eyes and proximal olfactory ganglia; *b*, the united sub-cere-bro-pleuro-pedal commissure; *c*, buccal and gastro-œsophageal ganglia; *dd*, sanguineous gland. Cam. luc. × 200 diam.

Fig. 2. Tubercle of skin. Cam. luc. × 200 diam.

Fig. 3. Portion of rhinophorial leaf. Cam. luc. × 350 diam.

Fig. 4. Two innermost teeth; *a*, first lateral tooth; *b*, second lateral tooth. Cam. luc. × 350 diam.

Fig. 5. Large lateral tooth, from the inner side. Cam. luc. × 200 diam.

Fig. 6. Large lateral tooth, from the outer side. Cam. luc. × 200 diam.

Fig. 7. Innermost portion of a series of teeth; *a*, rhachidian fold; *b*, the first; *c*, the eighth tooth. Cam. luc. × 200 diam.

Fig. 8. Portion of series of largest teeth. Cam. luc. × 200 diam.

Fig. 9. Outermost portion of a series of teeth; *a*, the outermost; *b*, the fourth tooth. Cam. luc. × 350 diam.

Fig. 10. *a*, Stomach; *b*, intestine; *c*, renal chamber.

Fig. 11. *a*, Spermatheca; *b*, its chief duct (vagina); *c*, spermatocyst; *de*, uterine duct.

Fig. 12. *a*, Spermatic duct; *b*, penis (the præputium is opened and the glans visible).

Figs. 13–18. *Archidoris australis*, Bergh.

Fig. 13. The central nervous system, from above; *ab*, cerebro-pleural ganglia; *c, c*, pedal ganglia; *d*, common commissure; *e, e*, proximal olfactory ganglia; *f*, distal olfactory ganglia; *g*, buccal ganglia; *h, h*, gastro-œsophageal ganglia; *i*, nervus genitalis issuing from ganglion genitale. Cam. luc. × 100 diam.

Fig. 14. Part of the margin of the branchial groove.

Fig. 15. Tubercles of the skin. Cam. luc. × 100 diam.

Fig. 16. Two of innermost lateral teeth; *a*, the innermost. Cam. luc. × 350 diam.

Fig. 17. Teeth of two different series from the outer side. Cam. luc. × 350 diam.

Fig. 18. Outermost portion of two different series of teeth with five and three teeth; *a, a*, the outermost ones. Cam. luc. × 350 diam.

Figs. 19–22. *Discodoris morphæa*, Bergh.

Fig. 19. Otocyst on the surface of the cerebral ganglion (*a*). Cam. luc. × 350 diam.

Figs. 20, 21. Spicules from skin. Cam. luc. × 200 diam.

Fig. 22. *a*, Œsophagus; *b*, stomach, behind which is the upper portion of the gall bladder; *ccc*, intestine; *dd*, liver.

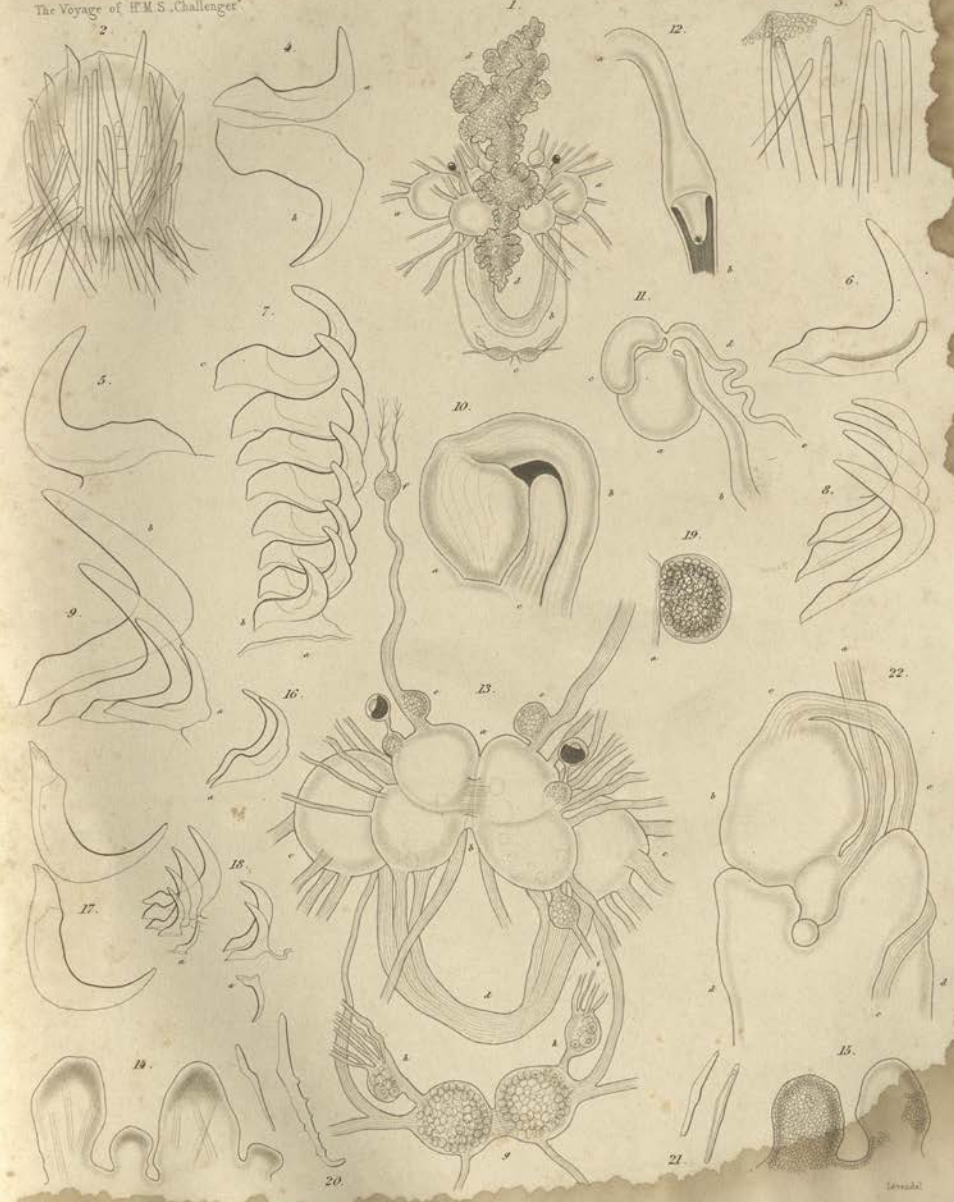
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PLATE II.

PLATE II.

Figs. 1–12. *Discodoris morphœa*, Bergh.

Fig. 1. Median section of a dorsal tubercle. Cam. luc. × 200 diam.

Fig. 2. Prehensile ring; *a*, upper part; *b*, lower part. Cam. luc.

Fig. 3. Portion of upper end of the same. Cam. luc. × 750 diam.

Fig. 4. Points of some of the elements from above. Cam. luc. × 900 diam.

Fig. 5. Middle portion of the radula; *a*, rhachidian fold; *b, b, b*, first lateral teeth. Cam. luc. × 350 diam.

Fig. 6. One of the largest teeth, from the outer side. Cam. luc. × 350 diam.

Fig. 7. Another, from the inner side. Cam. luc. × 350 diam.

Fig. 8. Another, seen obliquely from the under surface. Cam. luc. × 350 diam.

Fig. 9. Outermost part of two series of teeth; *a*, outermost tooth; *b*, the sixth; *c*, cuticular folds. Cam. luc. × 350 diam.

Fig. 10. Part of the pulp of the radula; *a*, posterior; *b*, anterior part. Cam. luc. × 350 diam.

Fig. 11. Salivary glands; *a, a*, efferent ducts; *b, b*, hinder attenuated ends of the glands.

Fig. 12. *a*, Spermatocyst; *b*, inner portion, *c*, outer portion, of uterine duct.

Fig. 13. *Archidoris australis*, Bergh.

Fig. 13. Portion of kidney; *a*, urinary chamber. Cam. luc. × 55 diam.

Figs. 14–17. *Ceratosoma cornigerum*, Adams.

Fig. 14. Anterior end of Bulbus pharyngeus, with the labial disk and the oral aperture.

Fig. 15. Outer part of three series of teeth; *a, a*, outermost teeth. Cam. luc. × 750 diam.

Fig. 16. *a*, Muscular part of vas deferens; *b*, upper solid portion of penis; *c*, its termination in the præputium.

Fig. 17. *a*, Spermatheca; *b*, vaginal duct; *c*, vagina; *d*, uterine duct; *e*, spermatocyst.

Figs. 18–24. *Platydoris eurychlamys*, Bergh.

Fig. 18. Median part of radula; *a, a*, first lateral teeth. Cam. luc. × 350 diam.

Fig. 19. Outermost parts of three series of teeth (5–5–2); *a, a, a*, outermost teeth. Cam. luc. × 350 diam.

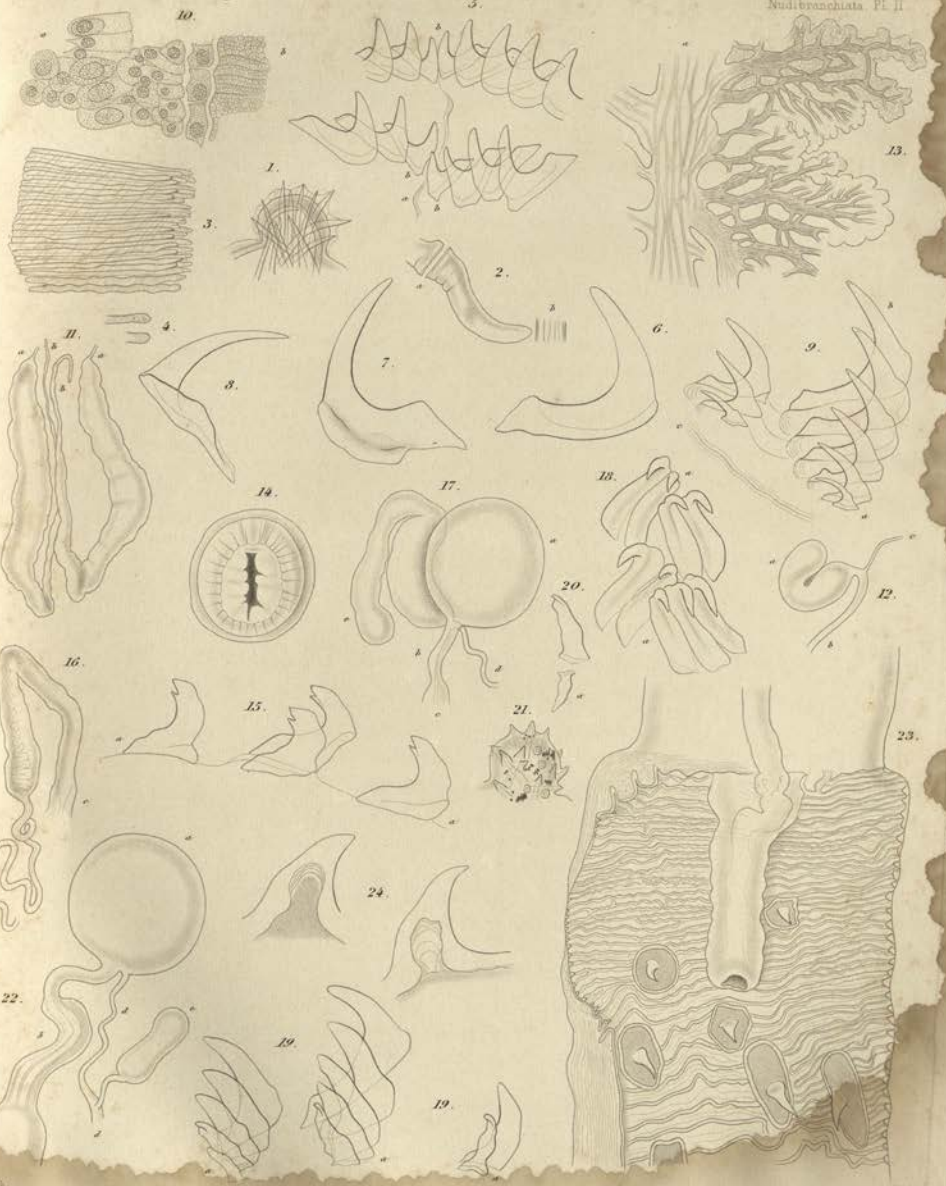
Fig. 20. Two outermost teeth; *a*, supplementary tooth. Cam. luc. × 350 diam.

Fig. 21. A dorsal tubercle. Cam. luc. × 200 diam.

Fig. 22. *a*, Spermatheca; *b*, vaginal duct; *c*, vagina; *dd*, uterine duct; *e*, spermatocyst.

Fig. 23. Upper portion of penis, opened to show the glans within the præputium and several disks. Cam. luc. × 100 diam.

Fig. 24. Hooks of two of these disks. Cam. luc. × 350 diam.



E. Bergh.

Lövendal.

PLATE III.

PLATE III.

Figs. 1–12. *Platydoris eurychlamys*, Bergh.

Fig. 1. *a*, Buccal ganglia; *b*, *b*, gastro-œsophageal ganglia. Cam. luc. × 55 diam.
Fig. 2. *a*, Proximal; *b*, distal, olfactory, ganglion. Cam. luc. × 55 diam.
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Fig. 7. One of the smaller disks of the præputium, from above. Cam. luc. × 350 diam.
Fig. 8. Hooks of two of the larger disks, from the side. Cam. luc. × 350 diam.
Fig. 9. Lower part of præputium. Cam. luc. × 100 diam.
Fig. 10. Villi from the surface of the ventricle of the heart (pathological). Cam. luc. × 100 diam.
Fig. 11. *a*, Posterior; *b*, anterior part of the salivary gland.
Fig. 12. *a*, Hermaphrodite duct; *b*, its ampulla; *c*, constricted part of the same; *d*, female branch; *e*, male branch; *f*, prostate; *g*, thinner part of the vas deferens; *h*, thicker part; *ii*, penis; *k*, vestibular gland.

Fig. 13. *Discodoris morphæa*, Bergh.

Fig. 13. *a*, Ampulla of the hermaphrodite duct; *b*, female branch; *c*, male branch; *d*, prostate; *e*, vas deferens; *f*, penis.

Figs. 14–20. *Ceratosoma cornigerum*, Adams.

Fig. 14. Otocyst on the surface of cerebral ganglion (*a*). Cam. luc. × 350 diam.
Fig. 15. Spicules from capsule of cerebral ganglion. Cam. luc. × 350 diam.
Fig. 16. Hooks of the labial disk. Cam. luc. × 750 diam.
Fig. 17. Part of the rhachis of the radula; *a*, median rhachidian thickening of cuticle; *b*, *b*, innermost lateral teeth (from the inner side). Cam. luc. × 750 diam.
Fig. 18. Lateral tooth, from behind. Cam. luc. × 750 diam.
Fig. 19. Two lateral teeth from the middle of a series, from the side. Cam. luc. × 750 diam.
Fig. 20. Part of the rhachis; *aa*, *b*, *b*, as in fig. 17. Cam. luc. × 350 diam.

Figs. 21–25. *Thordisa* (?) *clandestina*, Bergh.

Fig. 21. Part of the rhachis of the radula, with the innermost teeth of two series. Cam. luc. × 350 diam.
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Fig. 23. Innermost teeth of two series, from the side. Cam. luc. × 750 diam.
Fig. 24. A lateral tooth, from the side. Cam. luc. × 750 diam.
Fig. 25. Outermost portion of two series of teeth, with 5 and 7 teeth; *a*, *a*, outermost teeth. Cam. luc. × 750 diam.

Figs. 26–29. *Chromodoris striatella*, Bergh.

Fig. 26. Elements of the labial plate. Cam. luc. × 750 diam.
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Fig. 30. *Euplocamus japonicus*, Bergh.

Fig. 30. Spicules of the skin. Cam. luc. × 200 diam.

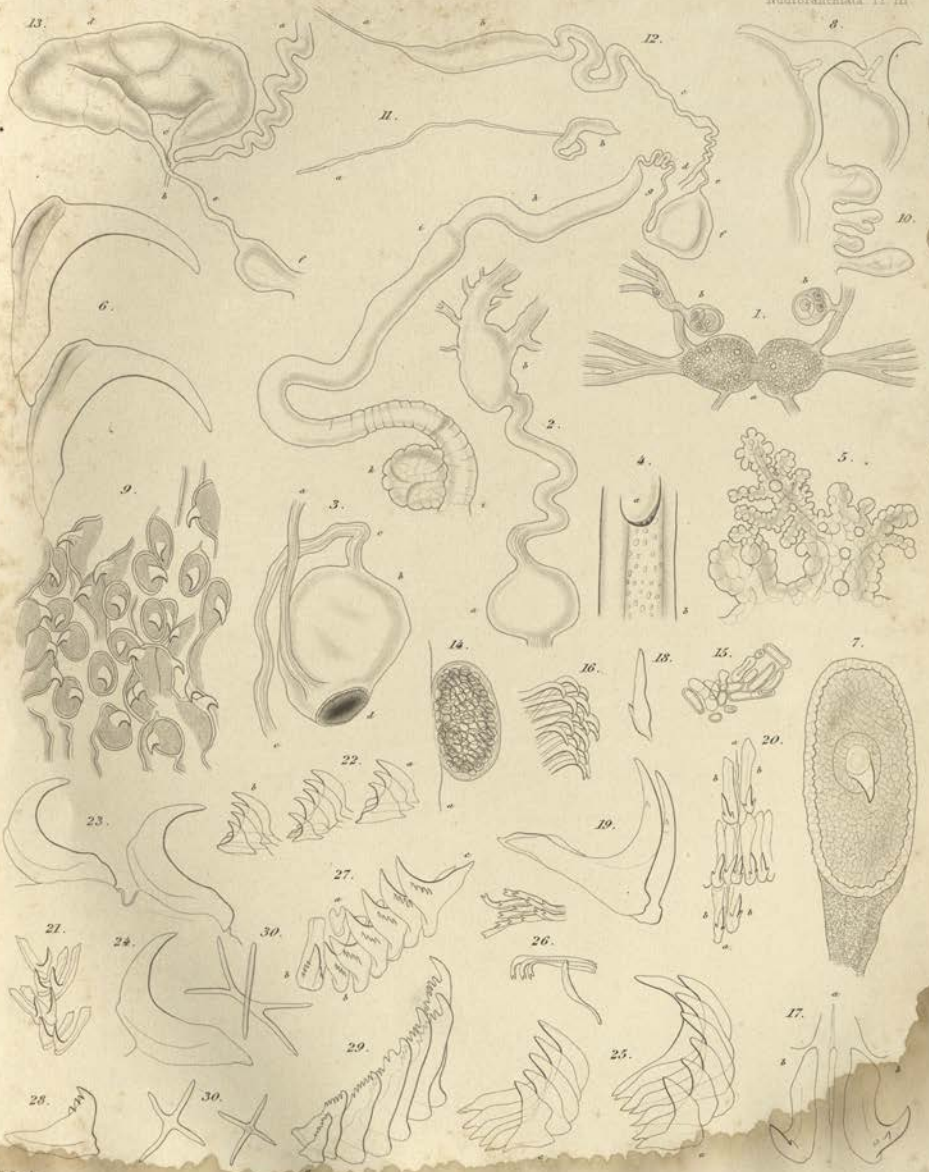
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PLATE IV.

PLATE IV.

Figs. 1–4. *Chromodoris striatella*, Bergh.

Fig. 1. *a*, *a*, Buccal; *b*, *b*, gastro-œsophageal ganglia. Cam. luc. × 100 diam.

Fig. 2. Two teeth from the outermost third of a series of teeth. Cam. luc. × 750 diam.

Fig. 3. *a*, Truncus aortæ; *b*, the ventricle; *c*, atrium; *dd*, hinder part of renal organ, in the middle is the renal chamber with its continuation into the ureter, on the right side the renal syrinx with its duct, behind the vena hepatica magna.

Fig. 4. *a*, Spermatheca; *b*, vaginal duct; *c*, uterine duct; *d*, spermatocyst.

Figs. 5, 6. *Doriopsis nebulosa*, Pease.

Fig. 5. Everted glans penis, showing *a*, armature continuous with that in interior of vas deferens. Cam. luc. × 350 diam.

Fig. 6. End of glans penis. Cam. luc. × 750 diam.

Figs. 7–24. *Euplocamus pacificus*, Bergh.

Fig. 7. Central nervous system, from the upper side; *a*, cerebral; *b*, *b*, visceral; *c*, *c*, pedal ganglia; *d*, common commissure; *e*, *e*, proximal olfactory ganglia; *f*, buccal ganglia. Cam. luc. × 100 diam.

Fig. 8. The same, from behind. Letters as above.

Fig. 9. Otocyst upon the surface of the ganglion (*a*). Cam. luc. × 350 diam.

Fig. 10. A spicule of the skin. Cam. luc. × 350 diam.

Fig. 11. Labial plate, from the inside; *a*, its upper end. Cam. luc. × 55 diam.

Fig. 12. The same, from the fore-end. Cam. luc. × 55 diam.

Fig. 13. Part of the radula, with 2 (3) series of teeth; *a*, *a*, first; *b*, *b*, second lateral teeth; *c*, *c*, outermost teeth. Cam. luc. × 100 diam.

Fig. 14. *a*, First, *b*, second, lateral tooth, from above. Cam. luc. × 200 diam.

Fig. 15. The same, from the side. Cam. luc. × 200 diam.

Fig. 16. First (innermost) and second of the outer teeth, from the inner side. Cam. luc. × 200 diam.

Fig. 17. *a*, Fourth; *b*, fifth tooth, from above. Cam. luc. × 200 diam.

Fig. 18. Outer teeth, from above; *a*, *a*, the innermost. Cam. luc. × 200 diam.

Fig. 19. Basal portion of teeth; *a*, third tooth; *b*, sixth. Cam. luc. × 350 diam.

Fig. 20. Fore end of armature of ductus ejaculatorius. Cam. luc. × 350 diam.

Fig. 21. Hinder end of same. Cam. luc. × 350 diam.

Figs. 22, 22. Part of cuticle with hooks. Cam. luc. × 750 diam.

Fig. 23. *a*, Basal portion of spermatheca; *b*, vaginal duct; *c*, vagina; *dd*, uterine duct; *e*, spermatocyst.

Fig. 24. *a*, Funiculus spermaticus; *b*, præputium penis.

Figs 25–27. *Onchidium melanopneumon*, Bergh.

Fig. 25. Tubercle of the skin.

Fig. 26. Bulbus pharyngeus, from above; *a*, radula-sheath.

Fig. 27. Rhachidian portion of the radula; *a*, median; *b*, *b*, first lateral; *c*, *c*, second lateral teeth. Cam. luc. × 350 diam.

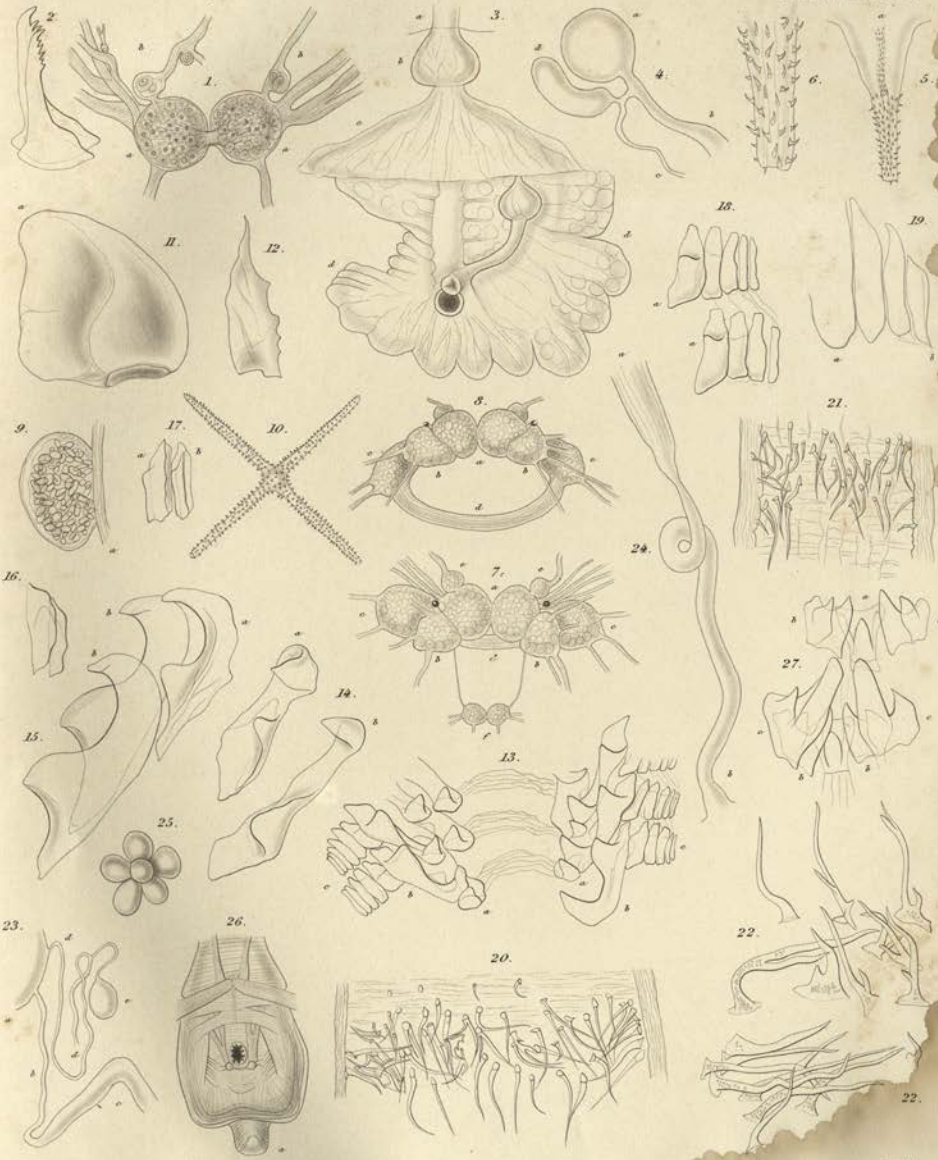
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PLATE V.

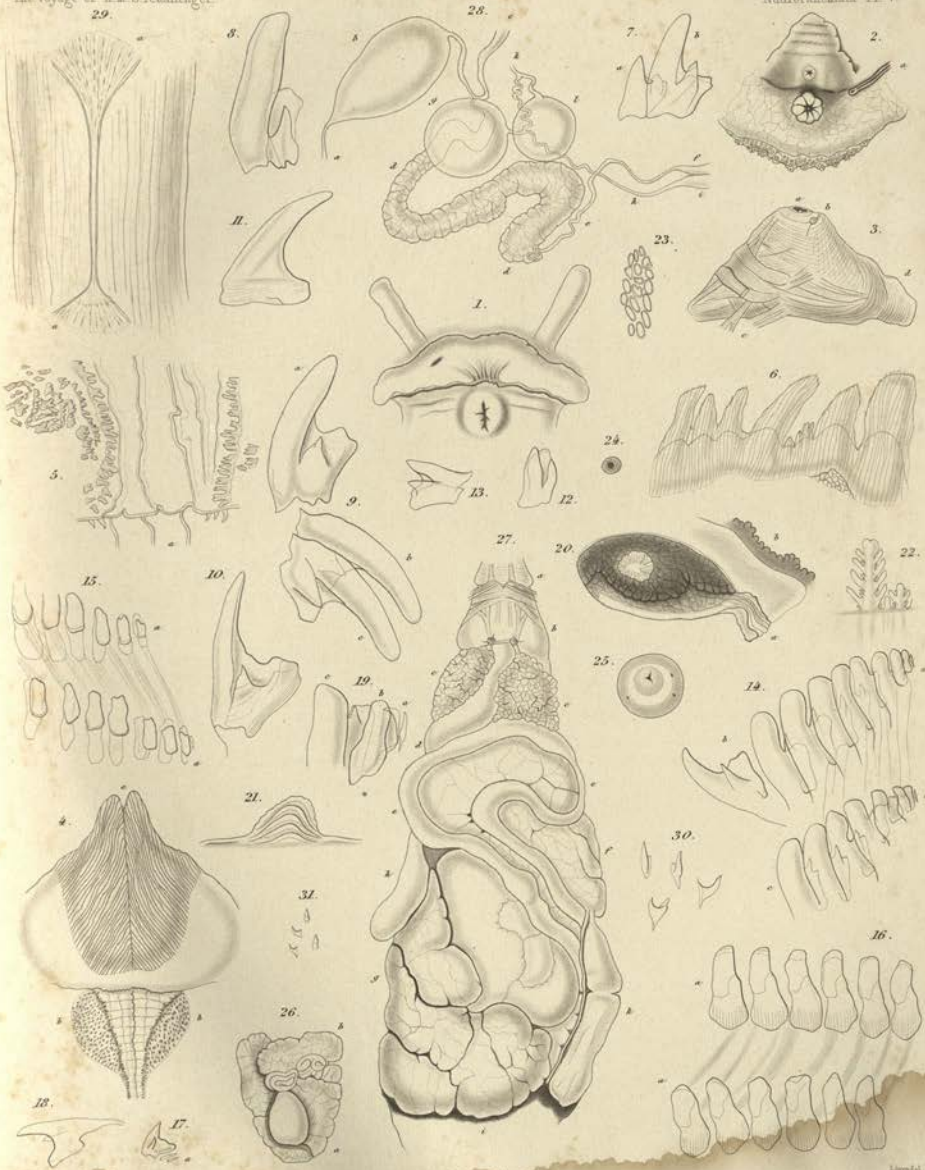
PLATE V.

Figs. 1–27. *Onchidium melanopneumon*, Bergh.

Fig. 1. Anterior end, showing rhinophoria, frontal shield (with orifice of penis), and the oral aperture.
Fig. 2. Posterior end of the animal (the tail turned upwards), viewed from beneath, showing anus, pneumostome, and (*a*), female genital furrow commencing at the vulva.
Fig. 3. Bulbus pharyngeus, from the side; *a*, pharynx; *b*, left buccal ganglion; *c*, protrusors of the bulbus; *d*, radula-sheath.
Fig. 4. Bulbus pharyngeus, opened on the upper side so as to show the tongue with radula (*a*); *b*, *b*, palatal plates, turned backwards.
Fig. 5. Portion of innermost part of palatal plates; *a*, free space between them. Cam. luc. × 55 diam.
Fig. 6. Part of palatal plates, from the side. Cam. luc. × 350 diam.
Fig. 7. *a*, First, *b*, second, lateral tooth. Cam. luc. × 350 diam.
Fig. 8. Second lateral tooth, obliquely from above. Cam. luc. × 350 diam.
Fig. 9. *a*, Second, *b*, third, *c*, fourth, lateral tooth, from the left side. Cam. luc. × 350 diam.
Fig. 10. Second tooth, from the side. Cam. luc. × 350 diam.
Fig. 11. Seventh tooth, from the inner side. Cam. luc. × 350 diam.
Fig. 12. First lateral tooth, from above. Cam. luc. × 350 diam.
Fig. 13. The same, from the outer side. Cam. luc. × 350 diam.
Fig. 14. Outer portion of two series of teeth, from the upper side; *a*, *a*, outermost teeth; *b*, tenth; *c*, eighth. Cam. luc. × 350 diam.
Fig. 15. Portion of outer end of two series of teeth, from below; *a*, *a*, outermost teeth. Cam. luc. × 350 diam.
Fig. 16. Part of external sixth of two series, from below; *a*, *a*, innermost of these teeth. Cam. luc. × 350 diam.
Fig. 17. Outermost tooth, from the outer side; *a*, cuticular folds. Cam. luc. × 350 diam.
Fig. 18. Outermost but two, from the outer side. Cam. luc. × 350 diam.
Fig. 19. Outermost three teeth, from behind; *a*, the outermost. Cam. luc. × 750 diam.
Fig. 20. Vertical section of lung and renal organ; *a*, pneumostome; *b*, dorsal surface.
Fig. 21. Lamellæ from third stomach, from the side.
Fig. 22. The same, from the end.
Fig. 23. Cuticle of second stomach. Cam. luc. × 55 diam.
Fig. 24. Section of dart-gland.
Fig. 25. Section of the ampulla of the dart-gland.
Fig. 26. The genital mass, seen obliquely from below; *a*, hermaphrodite gland; *b*, mucous gland, between them the spermatheca with its duct.
Fig. 27. The intestines from above; *a*, mouth-tube; *b*, bulbus pharyngeus with buccal ganglia; *c*, *c*, salivary glands; *d*, œsophagus; *ee*, intestine; *f*, anterior, *g*, posterior, liver; *h*, ampulla of duct of dart-gland; *i*, region of lung; *k*, heart (inner portion of pericardium left).

Figs. 28–31. *Doriopsis nebulosa*, Pease.

Fig. 28. *a*, Hermaphrodite duct; *b*, ampulla; *c*, oviduct; *dd*, prostate; *e*, muscular part of vas deferens; *f*, penis; *g*, spermatheca; *h*, vaginal duct; *i*, vagina; *k*, uterine duct; *l*, spermatocyst.
Fig. 29. Terminal part of vagina; *aa*, cuticular lining. Cam. luc. × 350 diam.
Fig. 30. Anterior armature of vas deferens (glans). Cam. luc. × 750 diam.
Fig. 31. Posterior armature of the same. Cam. luc. × 750 diam.



A. Borgh

Lövendal

PLATE VI

PLATE VI.

Figs. 1–4. *Chromodoris runcinata*, Bergh.

Fig. 1. Elements of the armature of labial disk. Cam. luc. × 750 diam.

Fig. 2. Outer part of three series of teeth; *a*, two outermost; *b*, second and third; *c*, third. Cam. luc. × 750 diam.

Fig. 3. Two teeth from the middle of a series. Cam. luc. × 350 diam.

Fig. 4. *a*, Spermatheca; *b*, vaginal duct; *c*, vagina; *d*, uterine duct; *e*, spermatocyst.

Figs. 5–18, 20, 21. *Onchidium melanopneumon*, Bergh.

Fig. 5. Median part of two series of teeth; *a*, median; *b*, *b*, *b*, *b*, first lateral teeth. Cam. luc. × 350 diam.

Fig. 6. *a*, Pharynx; *b*, œsophagus; *c*, superior bile duct; *d*, inferior bile duct; *e*, first stomach; *f*, second stomach; *g*, posterior bile duct; *h*, third stomach; *i*, ampulla of *k*, intestine.

Fig. 7. The same from the side; *b*, *c*, *e*, *f*, as above; *d*, inferior liver; *g*, posterior liver.

Fig. 8. Longitudinal section of inferior half of second stomach; *a*, opening into first stomach; *b*, recess in its cavity; *c*, posterior bile duct.

Fig. 9. Transverse section of the same.

Fig. 10. *a*, Posterior bile duct, with isolated small hepaticula.

Fig. 11. Part of atrium cordis, with *a*, atrio-ventricular valves.

Fig. 12. *a*, Hermaphrodite gland with coiled duct; *b*, mucous gland; *c*, duct of mucous gland (vagina); *dd*, vas deferens enclosed in the body wall (*cf.* fig. 21*c*); *ef*, its coiled-up portion lying in body cavity and ending in the penis, *g*; *h*, dart-gland; *ii*, ampulla of the duct (*k*); *l*, dart-sac.

Fig. 13. Lobules of hermaphrodite gland; *a*, duct. Cam. luc. × 100 diam.

Fig. 14. *a*, Common orifice (with protrusors) of dart sac *b*, and præputium *h*; *cc*, duct of (the ampulla of) the dart-gland; *d*, first free portion of vas deferens; *ee*, prostatic part of same; *fg*, muscular part; *h*, præputium; *i*, retractor muscle of the penis; *k*, its continuation into the common sac of præputium and dart.

Fig. 15. *a*, Common sac opened; *b*, præputium; *c*, vas deferens; *d*, dart-sac opened containing dart-cone; *e*, duct of (the ampulla of) the dart-gland.

Fig. 16. Præputium opened to show glans; *a*, vas deferens.

Fig. 17. End of glans penis.

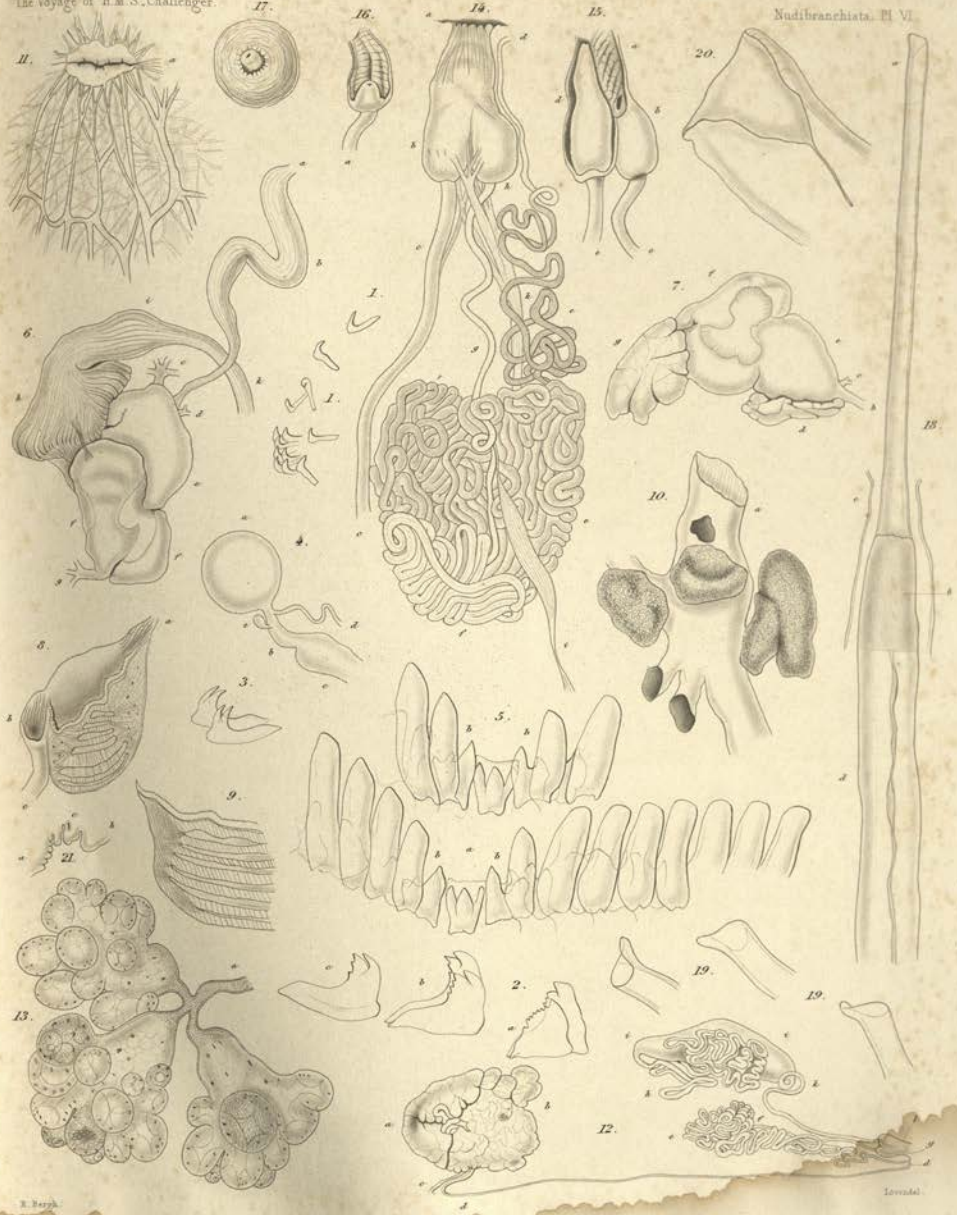
Fig. 18. The dart; *a*, point; *b*, base; *c*, wall of dart-cone; *d*, continuation of dart-duct. Cam. luc. × 100 diam.

Fig. 20. End of dart. Cam. luc. × 350 diam.

Fig. 21. Vertical section through body wall; *a*, internal part of genital furrow; *b*, external part; *c*, section of vas deferens.

Fig. 19. *Onchidium tonganum*, Quoy et Gaimard.

Fig. 19. Fore end of dart in various positions. Cam. luc. × 100 diam.



R. Berph.

Lovendal.

PLATE VII.

PLATE VII.

Figs. 1–6. *Onchidium tonganum*, Quoy et Gaimard.

Fig. 1. Vertical section through longitudinal axis of fore end of foot; *a*, fore end of foot; *b*, orifice of foot gland.

Fig. 2. Upper side of foot, from body cavity; *a*, mouth tube; *b*, foot gland; behind this the transverse muscular layer of foot, with entering nervi pediæi and opening of a vessel; *c*, *c*, longitudinal layers; *d*, muscles descending from the sides of the body.

Fig. 3. *a*, Præputium, opened and showing glans; *bb*, vas deferens; *c*, musculus retractor penis.

Fig. 4. End of glans penis; *a*, orifice at the point. Cam. luc. × 350 diam.

Fig. 5. *a*, Dart-cone opened; *b*, end of the duct of dart-gland; *c*, dart; *d*, nerve; *e*, retractor muscle.

Fig. 6. Dart; *a*, termination; *b*, base; *c*, duct. Cam. luc. × 100 diam.

Figs. 7–12. *Onchidium verruculatum*, Cuvier.

Fig. 7. Posterior end of body; *a*, pneumostome; *b*, anal papilla; *c*, vulva; *d*, genital furrow.

Fig. 8. Anterior end of foot from body cavity; *a*, mouth tube; *b*, foot gland; *c*, transverse muscular layer of foot.

Fig. 9. Portion of rhachis of radula; *a*, *a*, three median teeth; *b*, *b*, first lateral teeth. Cam. luc. × 350 diam.

Fig. 10. End of a lobule of salivary gland. Cam. luc. × 55 diam.

Fig. 11. End of (*d*) duct of dart-gland; *a*, dart-cone; *b*, dart; *c*, base of dart. Cam. luc. × 100 diam.

Fig. 12. End of dart; *a*, opening at its extremity. Cam. luc. × 750 diam.

Figs. 13–22. *Bornella excepta*, Bergh.

Fig. 13. Anterior end of animal, from the side; *a*, mouth; *b*, tentacles; *c*, anterior part of rhinophore with club and sheath; *d*, papillary part.

Fig. 14. The club of the rhinophore and its sheath, from above; *a*, part connecting it with the papillary part.

Fig. 15. Part of the labial disk; *a*, fore-end of the rods. Cam. luc. × 750 diam.

Fig. 16. Three lateral teeth of anterior incomplete series. Cam. luc. × 350 diam.

Fig. 17. Lobule of hermaphrodite gland; *a*, duct.

Fig. 18. Anterior part of the penis; *a*, orifice of seminal duct.

Fig. 19. Posterior part of the same.

Fig. 20. Constriction (*a*) between (*c*) prostatic and (*b*) muscular part of the vas deferens.

Fig. 21. Part of the margin of the penis. Cam. luc. × 100 diam.

Fig. 22. A single spine from the penis; *a*, base. Cam. luc. × 350 diam.

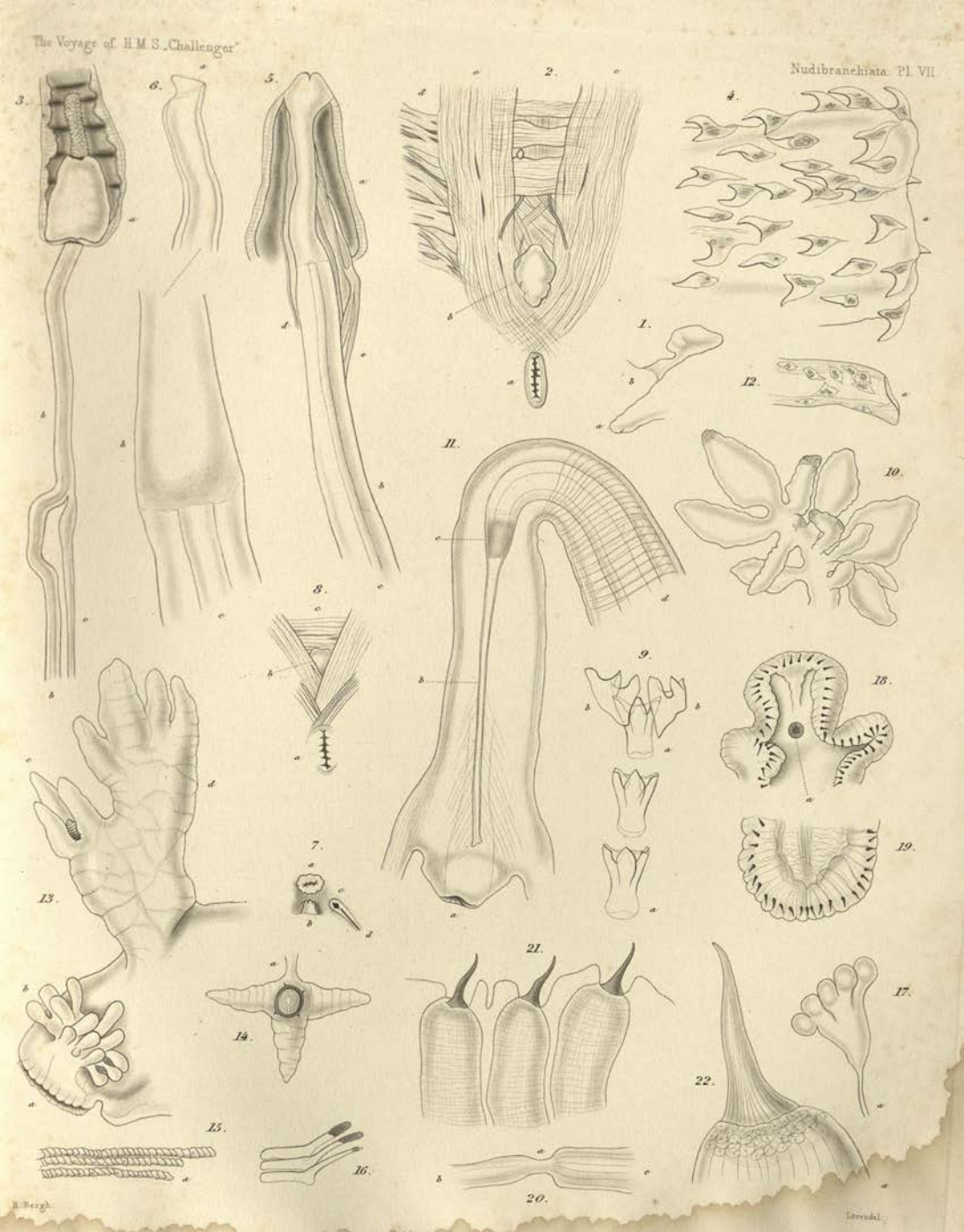

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PLATE VIII.

PLATE VIII.

Figs. 1–13. *Bornella excepta*, Bergh.

Fig. 1. Foremost papilla of left side, from the outer side ; *aa*, the back.

Fig. 2. Left mandible, from the outside ; *a*, hinge ; *b*, margo masticatorius. Cam. luc. × 55 diam.

Fig. 3. Upper part of left mandible ; *a*, hinge ; *b*, facet beneath the hinge. Cam. luc. × 55 diam.

Fig. 4. Two median teeth, from beneath. Cam. luc. × 350 diam.

Fig. 5. A median tooth, from the side. Cam. luc. × 350 diam.

Fig. 6. Median teeth, from the side. Cam. luc. × 350 diam.

Fig. 7. Median portion of radula, from above ; *a*, median ; *b*, *b*, first lateral ; *c*, fifth lateral tooth. Cam. luc. × 750 diam.

Fig. 8. Outermost part of two series, with 4–5 teeth ; *a*, *a*, outermost ; *c*, fifth. Cam. luc. × 750 diam.

Fig. 9. Digestive tract from beneath ; *a*, œsophagus ; *b*, first stomach ; *c*, *c*, two anterior liver masses with their ducts ; *d*, main liver mass, *e*, its duct ; *f*, second stomach ; *g*, first part of intestine ; *h*, constriction dividing it from the second portion, *ik*.

Fig. 10. Series of chitinous prickles from the second stomach. Cam. luc. × 100 diam.

Fig. 11. End of prickle. Cam. luc. × 350 diam.

Fig. 12. End of a renal tubule. Cam. luc. × 100 diam.

Fig. 13. Hermaphrodite gland ; *a*, efferent duct of this and another gland.

Fig. 14. *Onchidium verruculatum*, Cuvier.

Fig. 14. Dorsal tubercle with group of eyes.

Figs. 15–22. *Janolus australis*, Bergh.

Fig. 15. Bulbus pharyngeus, from the side ; *a*, musculus transversus postero-superior ; *b*, hinge part of mandibles ; *c*, œsophagus.

Fig. 16. Left mandible, from the outer side ; *a*, hinge part ; *b*, margo masticatorius.

Fig. 17. The same, from the inner side ; *a* and *b*, as above.

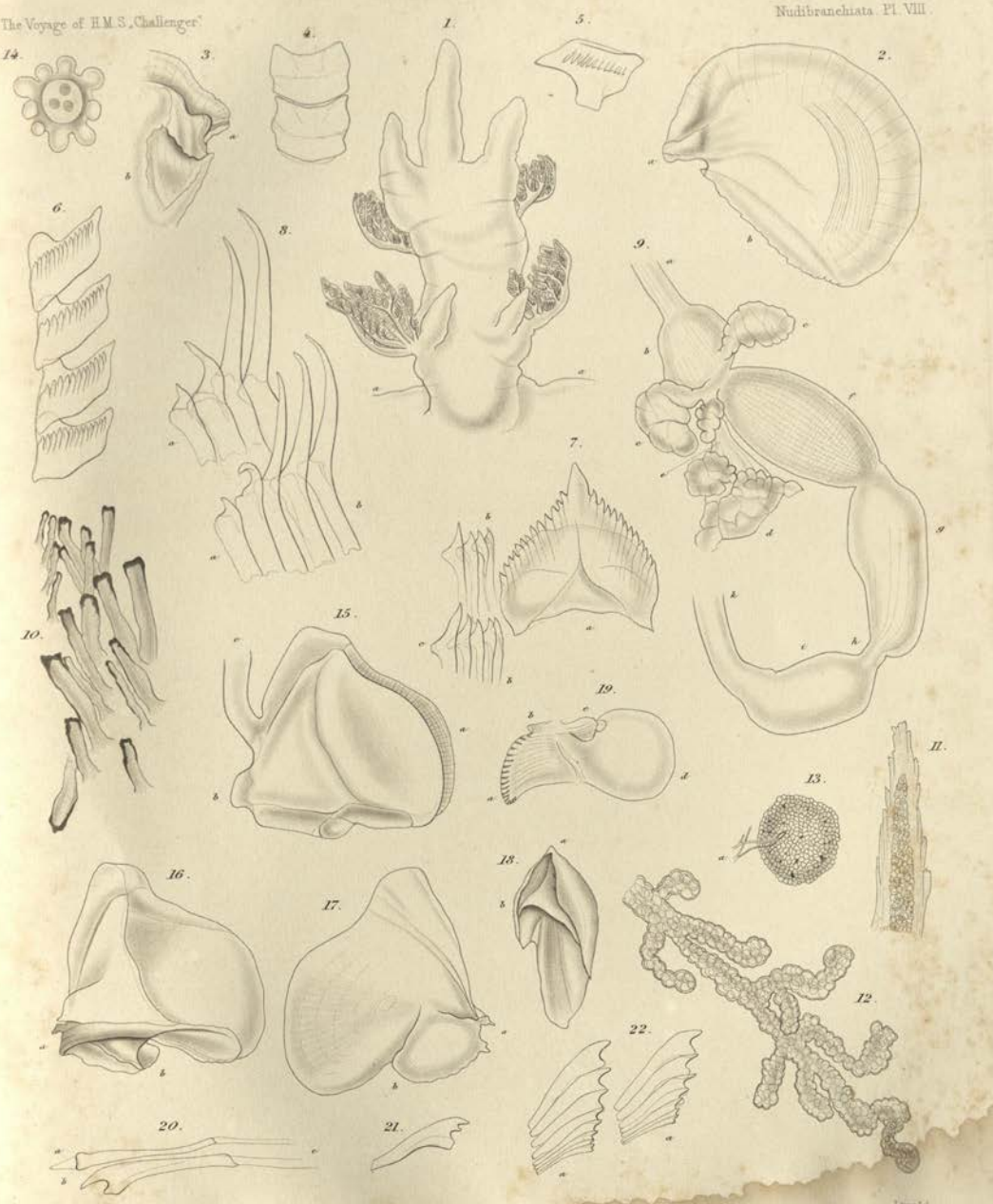
Fig. 18. The same, from beneath ; *a*, anterior end ; *b*, margo masticatorius.

Fig. 19. *a*, Tongue ; *b*, tectum radulæ ; *c*, vagina radulæ ; *d*, common muscular mass of the jaws.

Fig. 20. *a*, Median tooth from below ; *b*, first lateral tooth from the side ; *c*, cuticular continuation of teeth. Cam. luc. × 350 diam.

Fig. 21. Abnormal lateral tooth. Cam. luc. × 350 diam.

Fig. 22. Outer part of two series of teeth, with eight and seven teeth ; *a*, *a*, outermost teeth. Cam. luc. × 350 diam.



H. Bergh

Leivendal

PLATE IX.

PLATE IX.

Figs. 1–5. *Rizzolia australis*, Bergh.

Fig. 1. Part of margo masticatorius; *a*, processus masticatorius. Cam. luc. × 350 diam.

Fig. 2. Upper part of one of the teeth from radula. Cam. luc. × 350 diam.

Fig. 3. Two teeth, obliquely from the side. Cam. luc. × 200 diam.

Fig. 4. Another, in a similar position. Cam. luc. × 200 diam.

Fig. 5. A single tooth, obliquely from above. Cam. luc. × 200 diam.

Figs. 6–8. *Janolus australis*, Bergh.

Fig. 6. Central nervous system, from above; *ab*, cerebro-pleural ganglia; *c*, *c*, pedal ganglia; *d*, *d*, eyes. Cam. luc. × 55 diam.

Fig. 7. Median part of the radula (two series); *a*, *a*, median teeth; *b*, cuticular continuation of the same; *c*, *c*, first lateral plates. Cam. luc. × 350 diam.

Fig. 8. Outermost part of a series of teeth; *a*, outermost tooth. Cam. luc. × 350 diam.

Figs. 9–22. *Ohola pacifica*, Bergh.

Fig. 9. The animal, from above; *a*, *a*, posterior papillæ.

Fig. 10. Mandibular plate; *a*, transverse; *b*, longitudinal part. Cam. luc. × 100 diam.

Fig. 11. Part of the radula, with three series of teeth; *a*, rhachis with its folds; *b*, *b*, first lateral teeth; *c*, *c*, *c*, *c*, second lateral teeth; *d*, *d*, *d*, innermost external teeth; *e*, *e*, *e*, outermost external teeth. Cam. luc. × 200 diam.

Fig. 12. First lateral tooth, from the inner side. Cam. luc. × 350 diam.

Fig. 13. The same, in another position. Cam. luc. × 350 diam.

Fig. 14. *a*, First; *b*, second lateral tooth, from the inner side. Cam. luc. × 350 diam.

Fig. 15. Part of radula; *a*, *a*, second lateral teeth; *b*, innermost external tooth; *c*, outermost tooth. Cam. luc. × 350 diam.

Fig. 16. The two external plates; *a*, innermost. Cam. luc. × 350 diam.

Fig. 17. Innermost external plate, from the side. Cam. luc. × 350 diam.

Fig. 18. Anterior part of the armature of the vas deferens; *a*, *a*, walls of the vas deferens proper. Cam. luc. × 750 diam.

Fig. 19. Median part of the same; *a* as above. Cam. luc. × 750 diam.

Fig. 20. Posterior part of the same. Cam. luc. × 750 diam.

Fig. 21. Part of the renal tubules. Cam. luc. × 350 diam.

Fig. 22. *a*, Intestine; *b*, urethra *c*, end of the renal chamber; *d*, renal syrinx; *e*, pericardium.

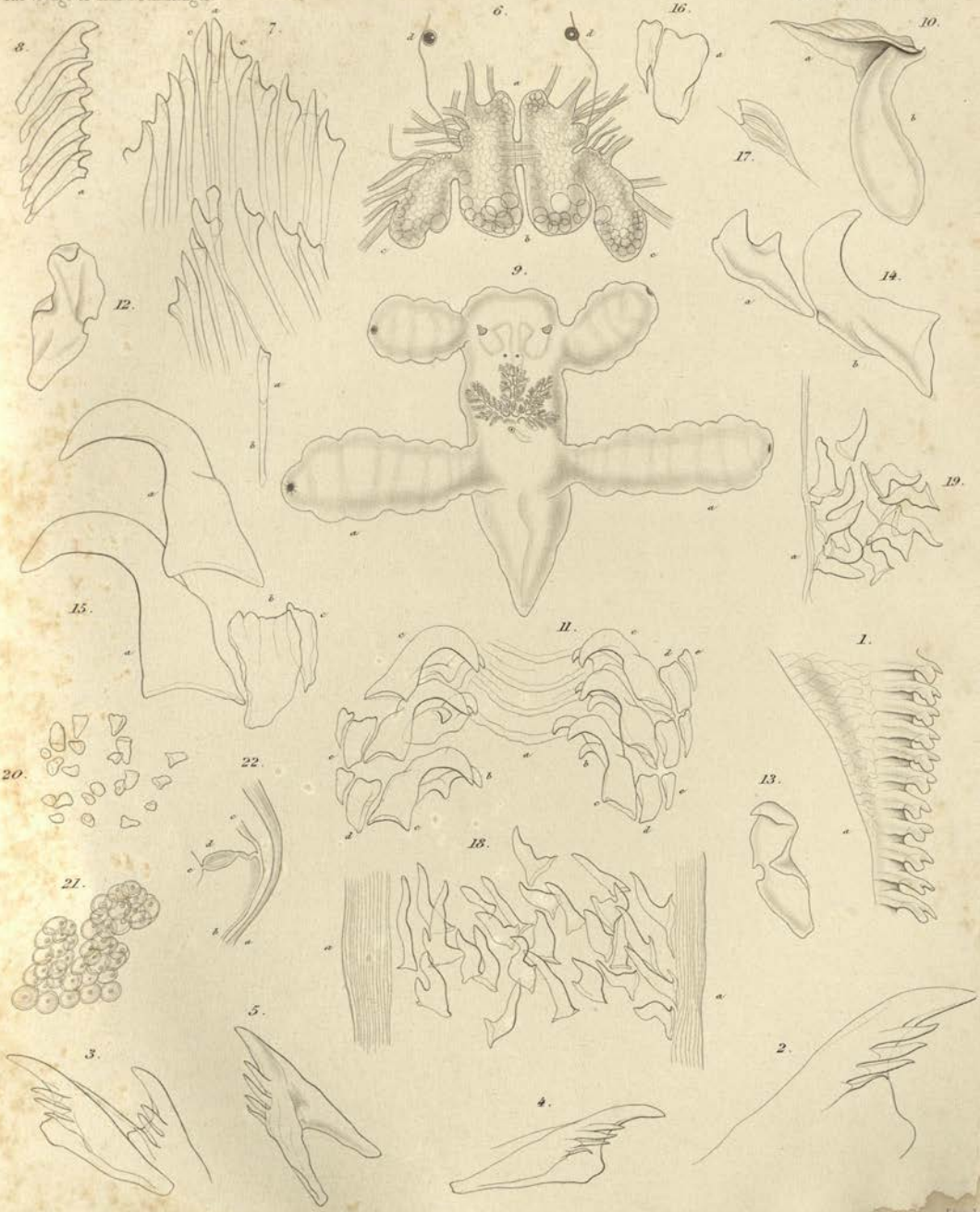

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PLATE X.

PLATE X.

Figs. 1–3. *Cuthonella abyssicola*, Bergh.

Fig. 1. The left mandible, from the outside, without being pressed; *a*, hinge with crista connectiva (on the inner side); *b*, end of processus masticatorius; *c*, the posterior limit of the succenturiate buccal cavity (Neben-mundhöhle). Cam. luc. × 55 diam.

Fig. 2. *aa*, The ejaculatory duct; *b*, side-duct from a gland (?); *cc*, the base of the præputium; *d*, glans penis; *e*, point of the penis. Cam. luc. × 55 diam.

Fig. 3. *a*, Spermatheca; *b*, duct of the same; *c*, opening in the vestibulum. Cam. luc. × 55 diam.

Fig. 4. *Acura pelagica*, Adams.

Fig. 4. The heart and the renal sac; *a*, pericardium; *b*, the atrium of the heart, and *c*, the aorta; *d*, renal syrinx; *e*, *è*, the renal chamber; *f*, the ureter. Cam. luc. × 55 diam.

Figs. 5–17. *Distomum glauci*, Bergh.

Fig. 5. The animal, from the under side; *a*, the oral, *b*, the ventral, sucker; *c*, the aperture through which the tail is retracted; the cavity of the body nearly filled with yellow cells (eggs). Cam. luc.

Fig. 6. Another individual in the same position; *a* and *b*, as above; *c*, the tail (with its retractors). Cam. luc.

Fig. 7. Another individual, from the side; *a*, *b*, *c*, as above; behind the oral sucker the genital papilla, along each side of the body the branch of the intestine. Cam. luc.

Fig. 8. Another individual, in similar position; *a*, *b*, *c*, as above; in the tail the branches of the intestine and the two egg-sacs. Cam. luc.

Fig. 9. The anterior half of an individual; *a*, the oral sucker; *b*, the genital papilla; *c*, the ventral sucker along the sides of the body the branch of the digestive channel (*d*). Cam. luc.

Fig. 10. A small individual without tail. Cam. luc.

Fig. 11. *a*, The oral sucker; *b*, *b*, the branches of the digestive channel; *c*, the two anterior branches of *d*, the excretory organ; *e*, the ventral sucker; *f*, the vesicula seminalis. Cam. luc.

Fig. 12. *a*, The left branch of the digestive channel; *b*, end of the excretory duct; *c*, *c*, the posterior end of the branches of the digestive channel (in the half-protruded tail). Cam. luc.

Fig. 13. Anterior end of the animal, with *a*, the oral sucker, and *b*, the genital papilla. Cam. luc.

Fig. 14. Another similar in somewhat different position. Cam. luc.

Fig. 15. The ventral sucker, from the side. Cam. luc.

Fig. 16. The genital papilla, with the penis covered with small prominences. Cam. luc.

Fig. 17. An egg. Cam. luc.

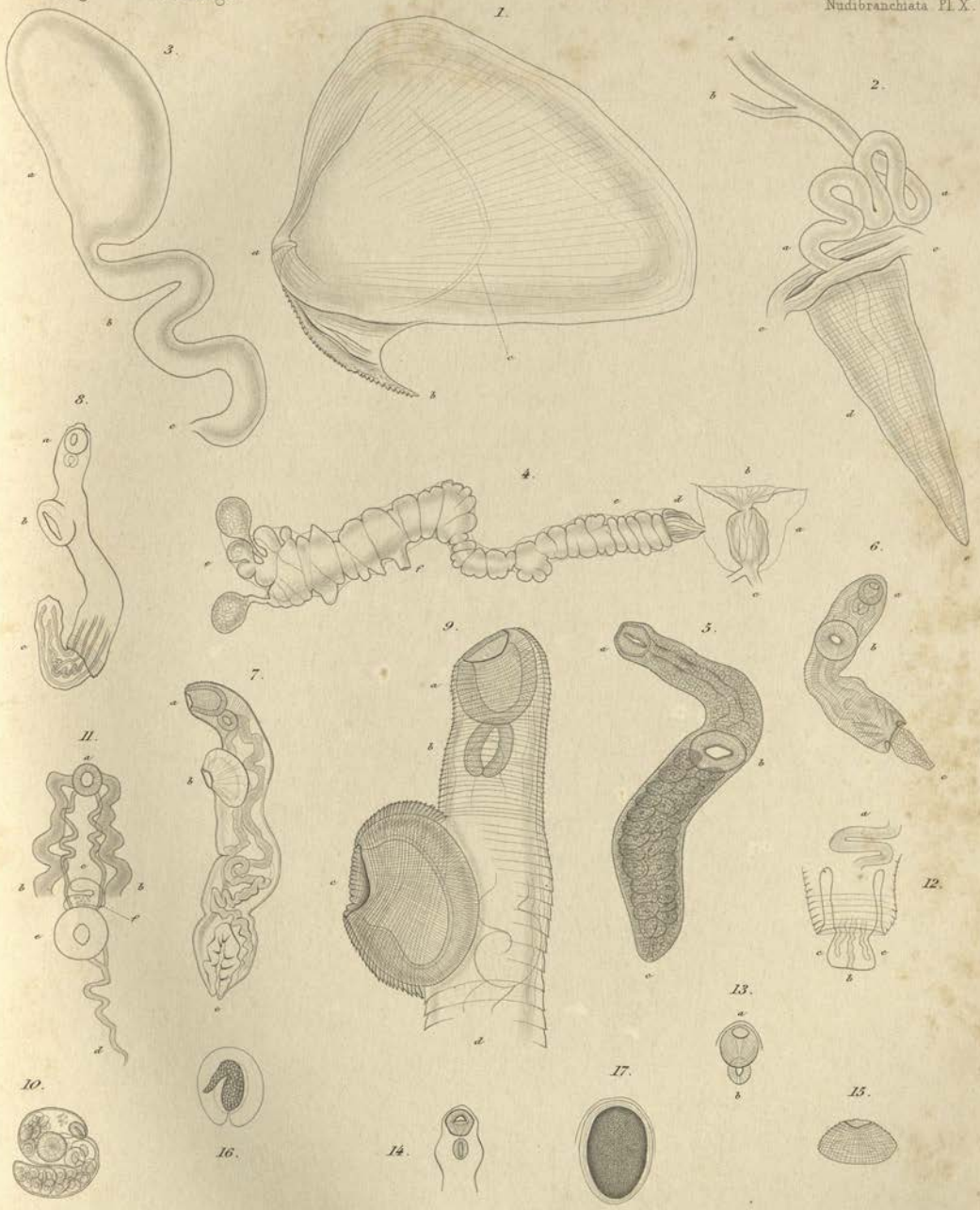
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PLATE XI.

PLATE XI.

Fig. 1. *Fiona marina* (Forskål).

Fig. 1. Loose plates of the radula, lying beneath the tongue in *a*, hindermost part of the buccal cavity (beneath the tongue). Cam. luc. × 100 diam.

Fig. 2. *Cuthonella abyssicola*, Bergh.

Fig. 2. Part of masticatory edge; *a*, hindermost part. Cam. luc. × 350 diam.

Figs. 3–15. *Marionia occidentalis*, Bergh.

Fig. 3. The central nervous system, from the under side; *a*, *b*, cerebro-pleural ganglia, with the otocysts; *c*, *c*, pedal ganglia; *d*, the united commissures; *e*, nervus genitalis; *f*, *f*, cerebro-buccal connective; *g*, buccal ganglia; *h*, *h*, gastro-œsophageal ganglia; *i*, the eye. Cam. luc. × 55 diam.

Fig. 4. The mandibles, from the anterior side; *a*, masticatory processes. Cam. luc.

Fig. 5. Part of the masticatory edge, from the inside; *a*, posterior part; *b*, anterior part. Cam. luc. × 350 diam.

Fig. 6. Upper part of the masticatory edge in the neighbourhood of the hinge, from the outside; *a*, anterior margin. Cam. luc. × 350 diam.

Fig. 7. Rhachidian part of the radula with two series; *a*, *a*, median plates; *b*, *b*, first lateral plates. Cam. luc. × 350 diam.

Fig. 8. Lateral plates, obliquely from the side. Cam. luc. × 350 diam.

Fig. 9. Lateral plate, from the side. Cam. luc. × 350 diam.

Fig. 10. Lateral plates, obliquely from the side. Cam. luc. × 350 diam.

Fig. 11. Outer part of a series of plates with four plates; *a*, outermost. Cam. luc. × 350 diam.

Fig. 12. The hook of a lateral plate. Cam. luc. × 750 diam.

Fig. 13. The largest of the stomachal plates. Cam. luc. × 55 diam.

Fig. 14. *a*, Spermatheca; *b*, its duct; *c*, vagina; *d*, vas deferens; *e*, glans penis.

Fig. 15. End of the glans penis; *a*, orifice of the seminal duct. Cam. luc. × 100 diam.

Figs. 16–19. *Tritonia challengeriana*, Bergh.

Fig. 16. The mandibles from the anterior side; *a*, masticatory processes. Cam. luc.

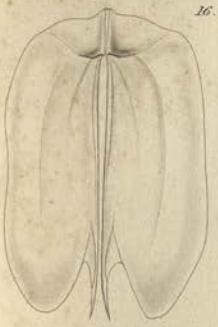
Fig. 17. Part of the masticatory edge; *a*, innermost part; *b*, anterior margin. Cam. luc. × 350 diam.

Fig. 18. Rhachidian part of a series of plates; *a*, median; *b*, *b*, first lateral plates; *c*, third plate. Cam. luc. × 350 diam.

Fig. 19. *aa*, Ductus ejaculatorius; *b*, præputium; *c*, *c*, musculi retractores penis; *d*, glans penis.

Fig. 20. *Scyllæa pelagica*, Linné.

Fig. 20. *a*, End of the ductus ejaculatorius; *b*, the half of the præputium taken away and the glans penis denuded.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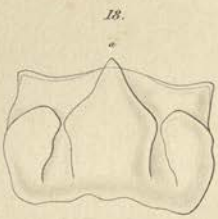
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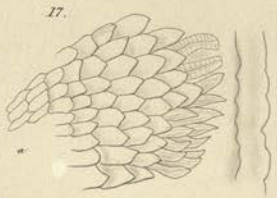
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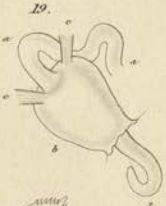
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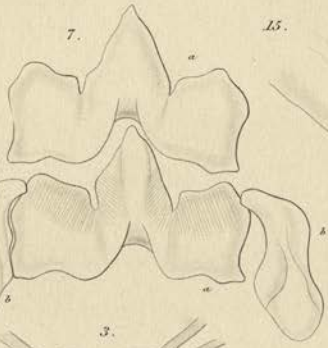
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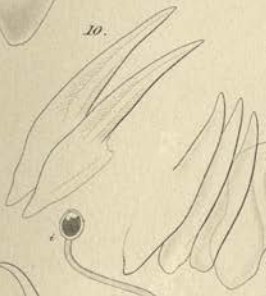
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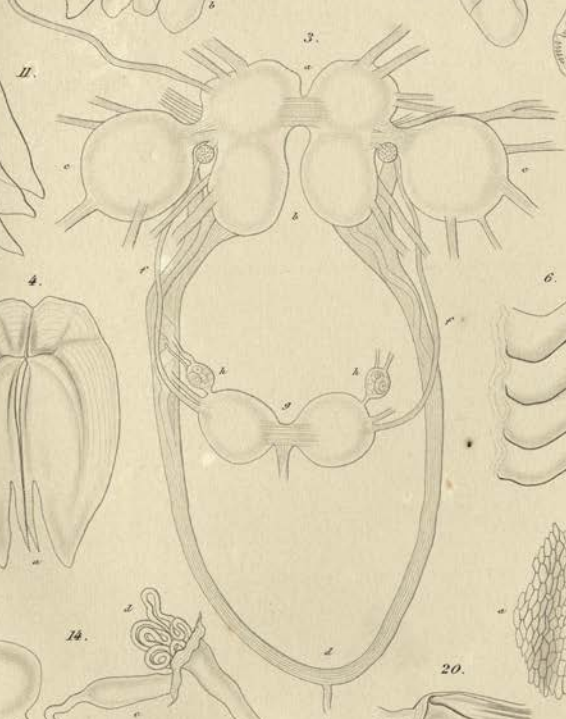
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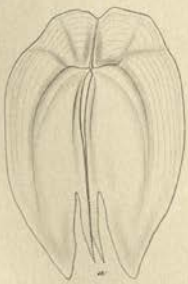
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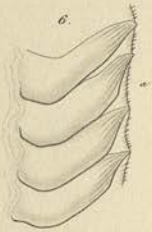
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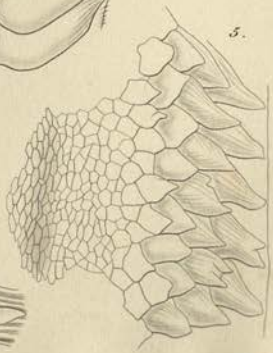
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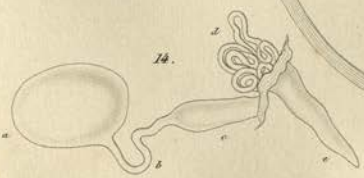
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PLATE XII.

PLATE XII.

Figs. 1–8. *Tritonia challengeriana*, Bergh.

Fig. 1. First lateral plate, from above. Cam. luc. × 350 diam.

Fig. 2. A lateral plate, from the outer side. Cam. luc. × 350 diam.

Fig. 3. Another, seen (shortened) from the inner side. Cam. luc. × 350 diam.

Fig. 4. Another, from the side. Cam. luc. × 350 diam.

Fig. 5. The broken point of the hook of a lateral plate. Cam. luc. × 350 diam.

Fig. 6. The outer part of four series with one to three plates; *a*, *a*, outermost. Cam. luc. × 350 diam.

Fig. 7. *a*, Renal syrinx; *b*, root of the duct of the organ.

Fig. 8. *a*, Spermatheca; *b*, its duct; *c*, the vagina.

Figs. 9–13. *Cuthonella abyssicola*, Bergh.

Fig. 9. *a*, Anus; *b*, renal pore; *c*, upper end of two series of papillæ belonging to the second group.

Fig. 10. Genital papilla with end of the glans; behind this the vulva (vagina) and aperture of the duct of the mucous gland.

Fig. 11. Basal plate of a lingual plate, from the under side. Cam. luc. × 350 diam.

Fig. 12. The point of the hook, from above. Cam. luc. × 350 diam.

Fig. 13. Two plates, from the side. Cam. luc. × 350 diam.

Figs. 14–20. *Bathydoris abyssorum*, Bergh.

Fig. 14. Fore-end of the animal, from the under side; *a*, *a*, rhinophoria; *b*, sole of the foot; *c*, genital papilla, with the præputium (and the point of the glans penis) and the aperture of the duct of the mucous gland. Natural size.

Fig. 15. Hinder end of the animal; *a*, *a*, sides of the body; *b*, sole of the foot. Natural size.

Fig. 16. Part of the skin of the back with papillæ.

Fig. 17. A lateral tooth of the outer half of a row, from above. Cam. luc. × 100 diam.

Fig. 18. Similar, from below. Cam. luc. × 100 diam.

Fig. 19. Four lateral plates from the outer sixth part of a row, obliquely from the outside; *a*, the outer. Cam. luc. × 100 diam.

Fig. 20. Renal tubules, from the peritoneum. Cam. luc. × 100 diam.

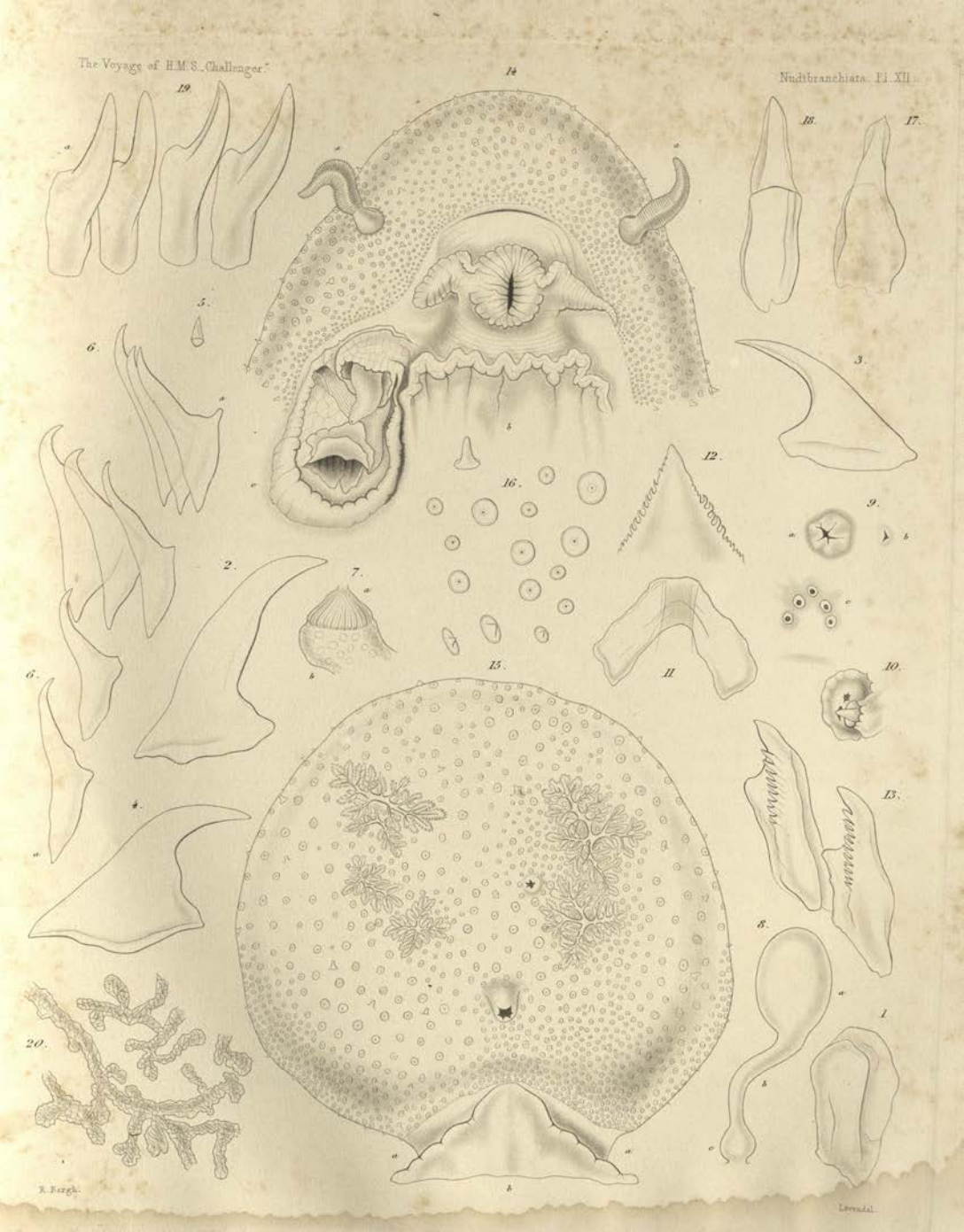
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PLATE XIII.

PLATE XIII.

Bathydoris abyssorum, Bergn.

Fig. 1. The animal on a reduced scale, from the anterior.

Fig. 2. The bulbus pharyngeus, from the side; *a*, labial disk, with its strong retractor muscles; *b*, *b*, muscular mass on the foreside of the mandibles; *c*, end of the radula sheath; *d*, end of the salivary gland, with its duct passing over the buccal commissure; *e*, the root of the œsophagus, with the right buccal ganglion.

Fig. 3. The same, from above; *a*, *b*,*b*, and *e*, as in fig. 2.

Fig. 4. Foreside of the mandibles, united by the thick cuticle of the buccal cavity (*cf.* fig. 6*b*), after the removal of muscular mass, resting on their foreside; the right mandible overlapping the left; *a*, under end.

Fig. 5. The right mandible, from the foreside; *a*, upper; *b*, under end; opposite the fig. 5 is the tooth.

Fig. 6. Perpendicular section through the length of the bulbus pharyngeus near the middle line; *a*, *c*, *e*, as in fig. 2. Behind the labial disk (*a*) the part of the bulbus lying in front of the mandible, clothed with a thick cuticle (*b*); *d*, free part of the left mandible; behind this the tongue, and beneath a transverse section of the musculus lingualis inferior.

Fig. 7. Rhachidian part of a row of plates; *a*, median plate; *b*, *b*, first lateral plate; *c*, second; *d*, third lateral plate. Cam. luc. × 100 diam.

Fig. 8. Median plate, from the side. Cam. luc. × 100 diam.

Fig. 9. Two other median plates, from the side. Cam. luc. × 100 diam.

Fig. 10. First lateral plate, from above. Cam. luc. × 100 diam.

Fig. 11. Irregular first lateral plate, from the side. Cam. luc. × 100 diam.

Fig. 12. Second lateral plate, from above. Cam. luc. × 100 diam.

Fig. 13. Fourth (*a*) and fifth (*b*) lateral plates, from above. Cam. luc. × 100 diam.

Fig. 14. Sixth lateral plate, from above. Cam. luc. × 100 diam.

Fig. 15. Four lateral plates, from the inner third of the radula, from above; *a*, irregular plate with short hook. Cam. luc. × 100 diam.

Fig. 16. Two others; *a*, with short hook. Cam. luc. × 100 diam.

Fig. 17. A piece of the outer fifth of a row, with three plates, obliquely from above. Cam. luc. × 100 diam.

Fig. 18. A similar plate, from the side. Cam. luc. × 100 diam.

Fig. 19. A similar plate, from the under side. Cam. luc. × 100 diam.

Fig. 20. A quite irregular plate. Cam. luc. × 100 diam.

Fig. 21. A double plate, from above. Cam. luc. × 100 diam.

Fig. 22. Another, from the side. Cam. luc. × 100 diam.

Fig. 23. A worn lateral plate from the anterior rows of the tongue. Cam. luc. × 100 diam.

Fig. 24. A similar plate. Cam. luc. × 100 diam.

Fig. 25. Part of the upper portion of the ureter.

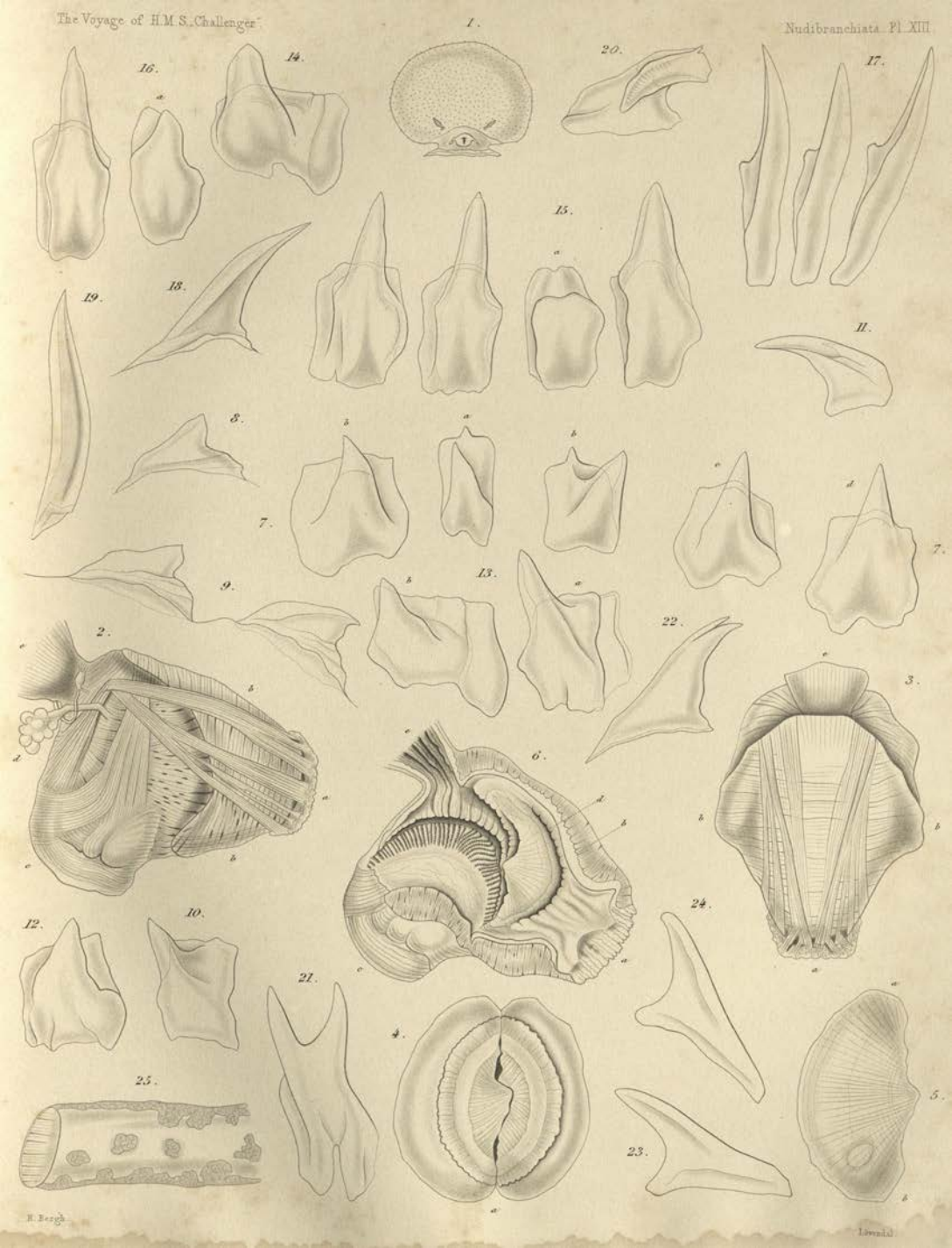
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PLATE XIV.

PLATE XIV.

Figs. 1–15. *Bathydoris abyssorum*, Bergh.

Figs. 1, 2. Papillæ of the back.

Fig. 3. A similar papilla; *a*, openings of the vessels and nerves.

Fig. 4. The central nervous system, from above; *a*, *a*, the cerebral ganglia; *b*, *b*, the two portions of the right pleural ganglion; *c*, pedal ganglion; *d*, the intercerebral and interpleural commissure; *e*, *e*, the cerebro-buccal connective; *f*, *f*, buccal ganglia; *g*, interbuccal commissure; *h*, common commissure. Cam. luc.

Fig. 5. Nerve ramification in the subcutaneous layer. Cam. luc. × 55 diam.

Fig. 6. *a*, The median plate; *b*, the first, and *c*, the second, lateral plate. Cam. luc. × 100 diam.

Fig. 7, 7. Part of the rhachis with four plates. Cam. luc. × 100 diam.

Fig. 8. First lateral plate of two series, from the side. Cam. luc. × 100 diam.

Fig. 9. Outer part of a series of plates (of the radula sheath) with nine plates, from the side; *a*, outermost. Cam. luc. × 100 diam.

Fig. 10. Outer part of two series of plates with nine and twelve plates, from above; *a*, *a*, the outermost. Cam. luc. × 100 diam.

Fig. 11. The hermaphrodite gland, from the under side, with the chief duct.

Fig. 12. Lobule of the gland.

Fig. 13. Zoosperm; *a*, head.

Fig. 14. *a*, Vas deferens; *b*, præputium; *c*, point of penis.

Fig. 15. Penis opened, with continuation of *a*, vas deferens out to the point *c*.

Glaucus atlanticus (Forster).

Fig. 16. Part of the margin of the processus masticatorius; *a*, behind. Cam. luc. × 750 diam.

Figs. 17, 18. *Tritonia challengeriana*, Bergh.

Fig. 17. Two lateral plates, obliquely from the inner side. Cam. luc. × 350 diam.

Fig. 18. A similar plate, more obliquely from the outer side. Cam. luc. × 350 diam.

Figs. 19, 20. *Marionia occidentalis*, Bergh.

Fig. 19. Masticatory plates of the stomach. Cam. luc. × 55 diam.

Fig. 20. One of the smallest plates. Cam. luc. × 55 diam.

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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the MYZOSTOMIDA collected during the Voyage of H.M.S. Challenger during the years 1873–76. By Dr. L. VON GRAFF, Professor of Zoology in the College of Forestry, Aschaffenburg, Bavaria.

PREFACE.

IN this Report sixty-eight species of Myzostomida are enumerated, of which fifty-two appear here for the first time. The Report includes, in addition to the specimens collected by the Challenger Expedition, all the new material which I have been able to gather together since the publication of my Monograph on the genus *Myzostoma*.[1] I am indebted to the editor of the Challenger publications, as well as to those who have kindly furnished me with collections, for the permission, in the interests of science, to collect all the information into the present memoir. I am specially indebted to Mr. P. Herbert Carpenter, through whom I have received fifty new species. He, at my request, and with a readiness which cannot be too highly appreciated, looked for and sent me, with all the information necessary, the specimens of *Myzostoma* not only from the Challenger collection of Crinoidea, but also from the many others which he has examined during the past few years. The following shows the principal sources from which I have obtained the specimens described in the memoir, and I take this opportunity of conveying my thanks to the gentlemen who have so generously placed collections in my hands for examination and description.

1. Challenger Expedition.
2. Dredging Expedition of the U.S.S. "Corvin," "Bibb," "Hassler," and "Blake" (Mus. of Comp. Zool., Harvard College, Cambridge, Mass., Prof. A. Agassiz).

[1] Das genus Myzostoma, mit 11 Tafeln., Leipsic, 1877.

3. The Copenhagen Museum (Dr. Ch. Lütken).
4. The Kiel Museum (Prof. K. Möbius).
5. The British Museum (Dr. A. Günther and Prof. F. Jeffrey Bell).
6. The Dutch Arctic Expedition of S.S. "Willem Barents," 1880–1881 (Kon. zool. Genootschap Nat. Art. Magistra, Amsterdam).
7. The Norwegian Arctic Expedition (Bergen Museum, Dr. A. Hansen).
8. The Leyden Museum (Prof. A. A. W. Hubrecht).
9. The private collections of Messrs. P. H. Carpenter, A. Agassiz, K. Möbius, E. Hæckel, and J. W. Spengel.

The most abundant and interesting material was obtained from Nos. 1–4.

I have indicated roughly the locality and also quoted the number of the Stations at which the different species collected during the Challenger and "Blake" Expeditions were found, since all the details are contained in the published lists of Stations of these two expeditions[1]; moreover, the geographical distribution of the Myzostomida being connected with that of their hosts, the Report on the Crinoidea, shortly to be published, will furnish the necessary information.

The names of the hosts new to science were communicated to me by Mr. Herbert Carpenter from his MSS. Finally, I wish to state that, following the suggestion of Dr. v. Willemoes Suhm,[2] I examined the figures of fossil Crinoidea in palæontological literature, as well as the actual fossils contained in the Munich collection, in order to find out, if possible, traces of Myzostomida, and was rewarded by discovering the cysts of the parasites upon the stalks of fossil *Pentacrini*. I intend to continue these investigations, and should feel very grateful if those gentlemen who have at their disposal collections of fossil Crinoidea would be so kind as to inform me if they notice any appearances like those drawn on Pls. XI–XV. of this work.

ASCHAFFENBURG, *October* 1, 1883.

[1] Appendix to the Introduction to the Zoological Reports, Zool. Chall. Exp., vol. i.; also, Narrative of the Cruise, vol. i.—List of Dredging Stations occupied by the United States Coast Survey Steamers "Corvin," "Bibb," "Hassler," and "Blake," from 1867 to 1879. Benjamin Pierce and Carlile P. Patterson, Superintendents of the Coast Survey, *Bull. Mus. Comp. Zool.*, Cambridge, Mass., vol. vi., No. 1, 1879.

[2] Von der Challenger Expedition, Brief VI., *Zeitschr. f. wiss. Zool.*, Bd. xxvi., 1876, p. lxxix.

INTRODUCTION.

The present Report, unfortunately, does not fill up all the many deficiencies in histological detail left in my former Monograph on the genus *Myzostoma*. This is owing partly to the fact that the material at my disposal was not in a very first-rate condition for minute anatomical research, and partly to the small number of specimens of many of the species—sometimes only one or two—which, of course, prevented me from using them for histological investigation. Although this Report is on the whole chiefly systematic, it will, I hope, be found to further our knowledge of the group in the following respects:—

1. It shows that the Myzostomida do not form such a uniform group as was formerly thought, either in structure or in mode of life.
2. The numerous new species render more intelligible the structure and arrangement of the various organs of the body, which is of assistance in fixing the boundaries of species.
3. Several of the new species throw considerable light upon the affinities of the group.

In order to render this Report more complete, I shall give, in the description of species, a short account of all the species already known, but not contained in the collections that I have in my hands at present.

The following is a brief account of the structure of *Myzostoma*, as far as it is known at present.

The body (fig. 1) is a circular disk, provided along the margin with ten pairs of digitiform processes. On the ventral side, arranged in two semicircles, are five pairs of non-articulate foot-stumps (parapodia), in the intervals between which, and nearer the margin, are four pairs of suckers; at the end of each of the parapodia is a bent pointed hook supported by a straight rod, which in order to guide the hook is furnished at its extremity with a bent end-plate (manubrium) and several smaller hooks. The whole apparatus is capable of extension and retraction by means of a complicated system of muscles radiating outwards from a central ventrally placed muscular mass. Close to the anterior end of the ventral surface is the mouth, and close to the posterior end is the aperture of the cloaca. The alimentary canal consists of a muscular pharynx, which can be extruded through the mouth, of an œsophagus separated by a valve from the stomach, which is itself separated by a circular fold from the terminal portion of the canal—the rectum; from the stomach a number of branched radiating cæca take their origin. Beneath the stomach is the large

oblong central nervous system, which gives off anteriorly a commissure surrounding the pharynx.

The sexual organs are hermaphrodite. The female organs consist of a number of ovarian cæca, dorsal in position ; they open into the cloaca by a central uterine tube. The testes are usually ventral in position, and ramify on either side of the stomach ; the cæca

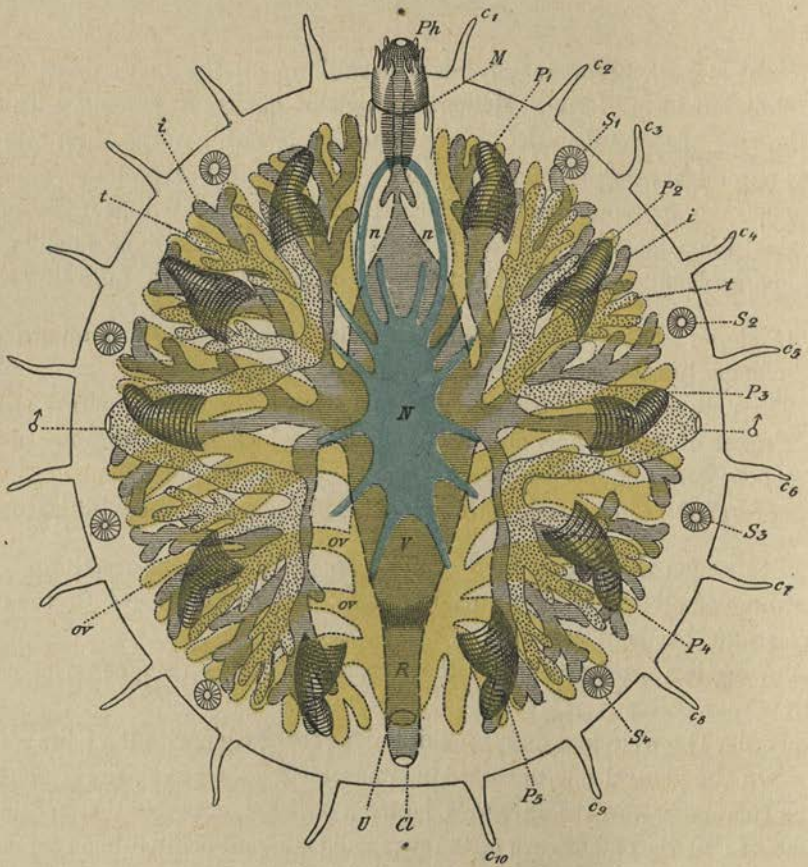

FIG. 1.—Diagram of the Structure of *Myzostoma*.

C_1-C_{10} the 10 pairs of cirri; *Cl*, cloacal opening; *i*, intestine; *M*, mouth; *N*, central nervous system (blue), with *n*, *n*, œsophageal ring; *ov*, ovarian tubes (yellow); P_1-P_5, the five pairs of parapodia; *Ph*, protruded pharynx; *R*, the rectum; S_1-S_4, the four pairs of suckers; *t*, testicular follicles; *U*, opening of the uterus into the rectum; *V*, stomach; ♂ the two lateral male genital openings.

unite on either side into a spermatic vesicle, which opens to the exterior between the third parapodium and the margin of the body.

The above description, with a few unimportant modifications, applies to all the species known up to the present time. I shall now show how far our knowledge of the anatomy of the group has been advanced by the new forms to be described in the present Memoir.

GENERAL MORPHOLOGY OF THE BODY.

Form of the Body.

All the Myzostomida hitherto known are characterised by the peculiar radial arrangement of the organs of the body. Corresponding to its disk-like form, we find the ten parapodia situated at pretty equal distances from each other, so that the whole body is divided into ten regular "parapodial sectors"; on the boundary lines between each of these are the eight suckers, the oral and the cloacal apertures. The sectors are separated inside the body by an equal number of radially arranged muscular septa, which thus form a number of similar compartments. The same radial arrangement is seen in the muscles of the hooks, especially in the strong musculi centrales, which unite in the middle of the body in a large muscular mass. In certain species where the axis of the body becomes lengthened, and so disturbs the circular arrangement of the suckers and parapodia, the radial character is nevertheless retained by the compartments, each corresponding to a single parapodium.

In the present Report several species will be described in which this radial arrangement is entirely lost; in some cases (*Myzostoma folium*) the body is greatly lengthened and the parapodia and suckers are situated in two parallel lines, while in the new genus *Stelechopus* not only has the external radial symmetry disappeared, but the muscular septa and the muscles of the parapodia are no longer convergent. In *Stelechopus* the septa are situated one behind the other at right angles to the axis of the body, running from the body-wall to the intestine, and the parapodia show the same bilateral symmetry, and their muscles are not united into a central muscular mass (Pl. XVI. fig. 1). If, as I have already[1] tried to prove, the radial arrangement of the musculature is indeed an adaptation to the mechanism of fixation, the want of this radial arrangement in *Stelechopus*, which undoubtedly moves about freely, must be regarded as the primitive arrangement.

Myzostoma glabrum has been until now the only exception to the general rule that the apertures of the body, as well as the parapodia and suckers, are situated upon its ventral surface; in this species the cloacal aperture is dorsal. I shall have in the present Report to describe two new species (*Myzostoma pulvinar* and *Myzostoma calycotyle*) in which the oral and cloacal apertures are upon one side of the body, while the parapodia and suckers are upon the other. If the parapodia alone be not sufficient to determine that

[1] *Loc. cit.*, p. 44.

to be the ventral surface of the body, the presence of the central nervous system conclusively proves it to be so, since this structure, as already stated, lies between the ventral muscular mass and the ventral wall of the body; in this way the opposite side of the body bearing the mouth and cloacal aperture must be regarded as the dorsal surface, since the intestine never lies below but always above the central muscular mass.

The two European species—*Myzostoma glabrum* and *Myzostoma cirriferum*—though they by no means represent the two extremes of the series, exemplify two groups which differ from each other in another respect. In the one the body is stout and massive and of a solid consistence; the back is usually vaulted; as a rule there are no cirri, or they are, if present, represented by short inconspicuous processes; the ventral surface is bulged out by the strongly developed muscular mass, and from this central elevation a number of smaller ridges run to the bases of the parapodia, and between them still smaller ridges connect the central elevation with the suckers. These ridges appear to be produced by the muscles of the parapodia—especially the musculus centralis—and the suckers; two other ridges, one running forwards and the other backwards, correspond to the pharynx and cloaca. On the dorsal surface one sees very often five pairs of feeble elevations, which mark the position of the base of the hook-apparatus, and in *Myzostoma testudo* become very much enlarged. Sometimes (*Myzostoma costatum*) the whole intestine shows itself on the outside, in the form of a series of elevated ridges.

In the other group the body is thin, flat, membranous, and somewhat transparent, with a more highly transparent marginal border, which is owing not merely to the slighter development of the muscles, but to the fact that the ramifications of the intestines and genital glands do not quite extend to the periphery of the animal (fig. 1). The greater delicacy of the body in this group is owing to the slighter development of the muscles of the body, especially of the ventral muscular mass; but the presence of a more transparent marginal border is not confined to these forms. The second group is also characterised by the possession of long cirri or cirrus-like processes of the margin of the body. The number of these is not limited to twenty, but occasionally exceeds that number.

There are, it is hardly necessary to say, numerous transitional forms, which unite the two groups, and can be with difficulty assigned to either; among these are the very remarkable forms distinguished by the possession of two, four, or six finger-like caudal appendages such as *Myzostoma lobatum* and *Myzostoma fissum*.

Colour and Sculpturing of the Skin.

As might be expected, the group containing the larger and stouter forms displays most variety in colour and sculpturing, though only on the dorsal surface—the ventral surface being always of a uniform dull yellow or brown. The second group are nearly all yellow or brown—the prevailing colour of the Myzostomida—with a somewhat lighter coloured

marginal border. The larger forms occasionally exhibit a pattern of two colours on the dorsal surface, as may be seen in the figures of *Myzostoma glabrum*,[1] *Myzostoma horologium*, *Myzostoma rubrofasciatum*, and *Myzostoma pictum*.[2] The first two species, the only ones of which I had abundant material, show at once how greatly the colour varies, and how unsafe it is therefore to fix the limits of a species by its colour. And this is owing to variations in the living animals and not merely to the fact that they are mostly known only by spirit specimens, in which case it is impossible to decide how much of the colour belongs to the *Myzostoma* itself, and how much is caused by the alcohol which contains the dissolved pigment of its host.

The dorsal surface is sculptured only in the larger specimens of the genus, which are also, as already mentioned, often distinguished by large elevations and ridges on the surface of the body. This sculpturing, when present, takes various forms: in *Myzostoma echinus* the dorsal surface is covered by fine folds (Pl. II. fig. 29); sometimes the skin is divided by longitudinal and cross furrows into a number of variously sized polygonal areas —minute in *Myzostoma coronatum* (Pl. III. fig. 9) but larger and separated by deeper furrows in *Myzostoma areolatum* (Pl. III. fig. 1); a third variety is shown by *Myzostoma gigas*, *Myzostoma longipes*, and *Myzostoma marginatum* (Pl. II. figs. 3, 24, and 16), where the skin is covered by a quantity of small tubercles pressed close together or separated by intervals into larger and smaller groups. The tubercles may be of equalsize, only diminishing slightly towards the border, or of very different dimensions; occasionally the tubercles become so minute and close that the skin acquires a granular appearance; on the other hand, these tubercles are sometimes highly developed, and arranged in radial lines (*Myzostoma echinus*, Pl. II. fig. 29).

In judging of the species by its sculpturing, it is always important to ascertain whether or not the animal was removed from its host before being plunged into alcohol, for in the former case it will be more bent towards the ventral side, and the dorsal surface will therefore be strongly projecting. All these circumstances evidently must considerably modify the sharpness of the sculpturing.

Cirri.

These structures are solid continuations of the integument, provided at their extremity with stiff setæ, and with a ventral furrow containing protrusile glutinous cells ("Klebzellen"); so the cirri serve not only as organs of attachment but also as tactile organs, as I observed in the case of *Myzostoma cirriferum* (*loc. cit.*, p. 29). Möbius also remarks that *Myzostoma mœbianum* used its cirri in locomotion, for clinging to the pinnules of its host (see special description of this species). The caudal appendages of certain other species of *Myzostoma*, already mentioned, differ from these cirri in being hollow and

[1] Genus Myzostoma, pl. i. figs. 1–11. [2] This Report, Pl. I. figs. 4–14; Pl. II. fig. 32; Pl. II. fig. 22.

containing prolongations of the intestinal cæca and generative glands. There exist, however, a number of transitional forms, which prove that these caudal appendages are merely peculiarly modified cirri; in several species (*Myzostoma filicauda, Myzostoma filiferum, Myzostoma quadrifilum, Myzostoma intermedium*) the caudal appendages are only hollowed out at the base, while the apical portion closely resembles a cirrus. In the last-mentioned species (Pl. IV. fig. 2) a transition is seen between the cirri and the caudal appendages, the outermost pair of which resemble the cirri far more closely than the inner pair. In *Myzostoma brachiatum* (Genus Myzostoma pl. ii. fig. 2) the cirri resemble the caudal appendages in being situated ventrally; the intestinal cæca, moreover, penetrate the bases of the larger cirri for a short distance, although in other respects they agree in structure with the small cirri; if the branches of intestine were to occupy the whole of the cirrus, it would become exactly similar to a caudal appendage. There is little doubt, therefore, that the two structures are homologous, and that both have the same conditions of growth. In consequence of which it may be that the size of the caudal appendages, as well as their presence or absence, and the length of the terminal threads, is only a sign of difference of age—as far as these conditions are proportionate to the size of the animal examined. But also the number of the caudal appendages is of doubtful value as a diagnostic character if we consider more closely the number of the true cirri.

By investigating individuals of various ages and species, and comparing all the forms that bear cirri, it is clear that with regard to the number present there are primarily two groups to be distinguished:—(1), those that possess from the very first ten pairs of these organs which do not subsequently increase in number; and (2), a second group in which their growth is unlimited, new lateral cirri appearing between the ten original ones. I am not able to state with certainty, from my examination of the material at my disposal, whether the growth of lateral cirri is at all limited, and whether there is any order or regularity of sequence in the appearance of the new ones. In any case there may be at length species in which the margin of the body is so covered that there is absolutely no room for any more (Pl. X. of this Report, and Genus Myzostoma, pl. x. fig. 1). There are but rarely less than ten pairs of cirri, if these organs be present at all; the encysted *Myzostoma tenuispinum* (Pl. XIII.), and *Myzostoma willemoesii* (Pl. XIV.), however, have only seven pairs. Besides the cirri there are in one species—*Myzostoma fimbriatum* (Pl. VI. figs. 5, 6)—bunches of fine threads along the margin of the body, which probably serve as tactile hairs.

Parapodia.

The parapodia have been already discussed, in so far as they influence the symmetry of the body. In some of the new species there is a new form of parapodium, in which the terminal portion is not a tube from the extremity of which protrude the hooks, but has

the form of a groove, rendering the hooks visible along their whole length (*Myzostoma wyville-thomsoni*, Pl. VI. fig. 1). The parapodium is thus divisible into two parts,—a larger basal portion, completely enclosing the hook-apparatus, and a grooved terminal portion. This form of parapodium is the extreme of a series which commences as a single wart-like prolongation, and then in correspondence with the development of the ventral muscular mass, shows a more or less distinct division into two parts, which becomes more and more marked.

In the description of species the distance of the parapodia from the margin of the body is given; this distance varies greatly, inasmuch as the parapodia are sometimes on the very edge of the body and sometimes crowded together at its centre; the point of insertion is often difficult to fix, since it is only marked distinctly on the external side of the parapodium, and ends on the inside in a centripetal elevation formed by the musculus centralis.

Hook-apparatus.—The two portions of this apparatus—the pointed hook (*uncinus*) and the supporting rod (*manubrium*) provided with a terminal end plate to direct the movements of the first—I have shown (*loc. cit.*, pp. 32, 33) to vary considerably in form according both to the species and the age of the individual examined. My recent investigations lend additional support to this statement, and I have not therefore paid much attention to these structures in fixing the species, especially as I was unable of course to mutilate unique specimens in order to examine them closely enough. The manubrium and the other parts of the hook-apparatus may fluctuate very widely in respect of structure and proportions in the parapodia of one and the same individual (*e.g.*, *Myzostoma horologium* and *Myzostoma gigas*).

The parapodia of the Myzostomida Cysticola become insignificant wart-like structures, and in the female of those species in which the sexes are separate there is no trace of the parapodia remaining, save a very feeble hook-apparatus, the muscles of which are very much reduced. It appears also that the column of the hook and manubrium are not, as I formerly thought, hollow, but in many species at least solid. When the hooks of *Myzostoma horologium* are treated with strong potash, the manubrial plate loses its refractive power, and nothing remains but a finely granular organic basis (Pl. I. fig. 17); then the column begins to flake, peels off in concentric layers, and there remains at length a central rod of a firmer consistency, which is only destroyed after being subjected for a longer time to the influence of the reagent. The same phenomena were observed in the large hooks of *Myzostoma gigas* (Pl. II. fig. 4).

Suckers.

It is interesting to find that there are some forms entirely unprovided with suckers, as, for instance, *Stelechopus* and many species of *Myzostoma* (*Myzostoma pulvinar*, *Myzostoma folium*, *Myzostoma coronatum*, *Myzostoma carinatum*, and all the encysted

Myzostomida except *Myzostoma willemoesii*). It would be desirable, however, to place this beyond a doubt by the help of sections, since it is always possible that (except in *Stelechopus* and the encysted species) there may be microscopic rudiments of suckers remaining; and, on the other hand, it is possible that certain cavities on the ventral surface of many species do not really represent suckers at all, as they were formerly supposed to do. It seems also the limit of the suckers and their appearance generally varies according to the different state of contraction in which they are.

The shape and arrangement of the suckers is also of importance for classificatory purposes. In *Myzostoma calycotyle* (Pl. III. figs. 25, 26) there are stalked suckers, which have a very singular relation to the parapodia, being situated quite close to their external sides, commencing from the middle line of the body. The general rule is that they occupy the middle of the interval between two parapodia.

Alimentary Canal.

I have already spoken of the general configuration of the alimentary canal, and its influence on the outer form of the body. It remains to be stated that there are species (*Stelechopus*) in which the alimentary canal, instead of being ramified and divided into stomach, intestines, &c., is simple and straight, with only feeble indications of lateral branches. This peculiarity, accompanied as it is by other important variations from the typical structure, is of great use for systematic purposes.

Generative Organs.

The suggestion made by v. Willemoes Suhm that some Myzostomida were in all probability dicecious, has been amply verified by my investigations, and I have also to add to our knowledge of the group many facts concerning the structure and disposition of the organs themselves. The following is a general account of the structure of these organs, leaving out the genus *Stelechopus*, which is but imperfectly known. The cloacal aperture is situated on a papilla, and is the common opening for the rectum and oviduct. The male sexual openings are two, corresponding to the number of the testes; they open on the ventral surface of the body, one on each side, between the third parapodium and the margin of the body. The apertures are sometimes simple, but sometimes their borders are prolonged into a tube-like continuation which is very contractile, and may assume therefore very different shapes even in the same species. The male apertures are absent, or only present on one side in the Myzostomida Cysticola, which is owing to the fact that the testes in this group are either absent or unilaterally developed.

Sexual Organisation of the Myzostomida Cysticola.

Von Willemoes Suhm [1] discovered, to his astonishment, that the individuals contained in a single cyst either resembled each other in form and size, or were very different, and concluded, though without having been able to examine the sexual organs, that in the latter case the individuals resembled *Distoma okenii*, in that one had the male organs especially developed, and the other the female organs.[2] I am able to state that this is really the case, that each individual is either male or female, and that in addition the two sexes are unlike in appearance, the female being usually 50–100 times as large as the male. That these forms (*Myzostoma tenuispinum*, *Myzostoma willemoesii*, *Myzostoma inflator*, *Myzostoma murrayi*) are originally descended from androgynous forms, in which the organs of one sex have become gradually abortive, is shown by the case of *Myzostoma cysticolum*, in the female of which there are rudiments of the testes, but no male generative aperture (Pl. XIII. fig. 4, *t*). These dicœcious forms are also distinguished by the marginal position of the sexual apertures, both male and female (Pls. XIII. and XIV.), and the form of the testes in the males. In *Myzostoma willemoesii* and *Myzostoma inflator* alone, which resemble the free living forms in the possession of twenty long cirri, the testes have the typical ramified form; in all the others they are compact roundish glands occupying definite areas in the lateral part of the body.

In those forms in which the individuals inhabiting one cyst are not different in appearance, the sexual organs have a different structure; each individual is here androgynous, but differs from the free living androgynous species in that the testis is developed only on one side of the body, and there is but one male genital aperture; in *Myzostoma pentacrini*, however, there are small remnants of the other testis, but no second male aperture. The testis also, as in the dicœcious forms, is a small compact gland. Since the testes of the dwarf males are fully developed on both sides, we must not regard the hermaphrodite species, *Myzostoma pentacrini* and *Myzostoma deformator*, as transitional between the typical hermaphrodite forms and those that are dicœcious, but the latter must be derived independently from the free-living forms.

More abundant materials are required before the question about the life history of the Myzostomida Cysticola can be definitely answered, but my investigations permit me to state that the following view is in all probability correct.

The male and female being found associated in a common cyst, and increasing in size with the growth of the cyst, shows that they perforate the arm-joints or pinnules of their host together. The growth of the cyst is of course caused by the presence of the parasite; the female deposits her eggs within the cyst, and the young embryos, after they

[1] Von der Challenger Expedition, Brief III., *Zeitschr. f. wiss. Zool.*, Bd. xxv., 1875, p. xxxi., and Brief VI., Bd. xxvi., 1876, p. lxxix.

[2] "Dass auch hier (wie bei *Distoma okenii*) das eine Thier sich namentlich für die männliche, das andere für die weibliche Thätigkeit entwickelt."

have abandoned the cyst and lost their ciliated coat, associate together in pairs, and bore their way through the arm-joints. In both the sexual development begins with the appearance of testes (*cf.*, *Myzostoma brevicirrum*, p. 43), but in the female the testes degenerate and disappear entirely, or leave but a minute rudiment (*Myzostoma cysticolum*), when the ovaries make their appearance in addition. The curious shape of the female—convex below and flat or concave above—is owing to the growth of the cyst, whose sides rise round the parapodia and press the lateral parts upwards.

Among the hermaphrodite forms, *e.g.*, *Myzostoma pentacrini* and *Myzostoma deformator*, it is impossible to say anything for certain about the relations between the individuals enclosed in one cyst. As three, two, and sometimes only a single individual are found in a cyst, it is evident that self-fertilisation must sometimes occur; and the fact that when more than one individual is found in one cyst they are separated by partitions to a smaller (*Myzostoma deformator*) or larger (*Myzostoma pentacrini*) extent, tends to show that it is the rule. In this case, therefore, it is by no means necessary that several individuals should be associated together in a common cyst, and the occurrence must be regarded as accidental.

Relation of Myzostomida *to their Host.*

The Myzostomida Cysticola are interesting to the zoologist and palæontologist, not only from their structure but also from the cysts they produce, which recall plant galls. Under the description of species, a detailed account of these structures and the frequency of their occurrence will be given. I may here briefly allude to the most important facts. The effect of the free-living Myzostomida on their host I have already discussed in my former Monograph, but I will add that I lately received from Naples, through the kindness of Dr. Spengel, a specimen of *Antedon rosacea*, bearing numerous examples of *Myzostoma cirriferum* upon its arms, and not less than sixteen large specimens of *Myzostoma glabrum* upon the disk.

Myzostoma asymmetricum is somewhat transitional between those forms that crawl freely about their host and those that are encysted. It is found attached to the ventral surface of the pinnules, which becomes slightly enlarged by the contact of the parasite, as does also the proximal arm-joint (Pl. XI. figs. 4–6). *Myzostoma willemoesii* causes a more marked malformation (Pl. XIV. figs. 6, 7); it is attached to the ambulacral surface of the pinnule, the joints of which become larger and more hollowed out, forming thus a canal; the whole pinnule is wound spirally, forming a chamber in which the parasite lives, which is closely similar to that produced by *Pemphigus bursarius* upon the stems of poplar leaves.

Myzostoma deformator bores its way into the interior of the pinnule, which becomes swollen and pear-shaped (Pl. XII.). Another kind of malformation is produced by the two species *Myzostoma pentacrini* and *Myzostoma tenuispinum*. The former causes insignificant thickenings of the arm-joints (Pl. XI. fig. 9) and fissures between them. Much more

remarkable are the cysts of *Myzostoma tenuispinum* (Pl. XIII. figs. 6 and 11–16), which consist of small fusiform oval chambers, arranged longitudinally or transversely, and formed by the enlargement of some of the brachialia or basalia; these are extremely conspicuous, since they do not become gradually flattened. A third group of malformations consist in independently formed cysts, *i.e.*, cysts that are not produced by the transformation of a pinnule or an arm-joint. These cysts appear upon the ambulacral surface, and are either sessile and of various forms (*Myzostoma cysticolum*, Pl. XIII. figs. 1–3), or pedunculate and club-shaped (*Myzostoma murrayi*, Pl. XV. figs. 5–9). *Myzostoma inflator* (Pl. XV. figs. 1, 2) produces both sessile and stalked cysts.

Finally, there are compound cysts (Pl. XIV. fig. 8), due to the approximation and fusion of the two different cysts formed by *Myzostoma willemoesii* and *Myzostoma tenuispinum*, the latter on the arm-joint and the former on its pinnule.

In the following Tables are given complete lists of the known species of *Myzostoma* and their hosts:—

TABLE I.

List of species of Myzostomida.

Species of *Myzostoma*.	Host.	Received from.
M. horologium, n. sp.	*Actinometra jukesi*, P. H. C.	Challenger Expedition.
	„ *strata*, P. H. C.	Do. do.
M. longipes, n. sp.	Uncertain.	"Blake."
M. chinesicum, n. sp.	Uncertain.	Dr. J. W. Spengel.
M. labiatum, n. sp.	*Antedon inæqualis*, P. H. C.?	Challenger Expedition.
M. echinus, n. sp.	*Antedon incisa*, P. H. C.?	Do. do.
	„ *inæqualis*, P. H. C.?	Do. do.
	Actinometra mutabilis, Lütken, MS.	Copenhagen Museum.
M. alatum, Graff.	*Antedon phalangium*, Müll., sp.	"Porcupine."
M. costatum, F. S. L.	*Antedon savignyi*, Müll., sp., or „ *palmata*, Müll., sp.?	Prof. v. Siebold.
	„ *triquetra*, Semp., MS.	Prof. C. Semper.
	Actinometra parvicirra, Müll., sp.	Do.
M. plicatum, n. sp.	*Antedon tenax*, Lütken, MS.	Copenhagen Museum.

Species of *Myzostoma*.	Host.	Received from.
M. rubrofasciatum, n. sp.	Uncertain.	Prof. E. Hæckel.
M. glabrum, F. S. L.	*Antedon rosacea*.	Many European Localities.
M. gigas, Lütken, MS.	*Antedon eschrichti*, Müll., sp.	Copenhagen Museum. Bergen Museum. "Porcupine."
	„ *eschrichti* or *quadrata*, P. H. C.	"Willem Barents." Challenger Expedition.
	„ *carinata*, Leach, sp.	Do. do.
M. testudo, n. sp.	*Actinometra lineata*, P. H. C.	"Blake."
M. lütkeni, n. sp.	*Actinometra intricata*, Lütken, sp.	Copenhagen Museum.
M. pallidum, Graff.	*Actinometra solaris*, Lam., sp.	Prof. C. Semper.
	„ *parvicirra*, Müll., sp.	Do.
M. marginatum, n. sp.	*Actinometra discoidea*, P. H. C.	"Blake."
M. brevipes, n. sp.	*Antedon pourtalesii*, P. H. C.	Do.
M. carpenteri, Graff.	*Antedon dentata*, Say.	"Triton."
M. areolatum, n. sp.	*Actinometra blakei*, P. H. C.	"Blake."
	„ *meridionalis*, var. *quadrata*, P. H. C.	Do.
M. triste, Graff.	*Actinometra parvicirra*, Müll., sp.	Prof. C. Semper.
	Uncertain.	British Museum. Copenhagen Museum.
M. coriaceum, n. sp.	*Antedon insignis*, Bell, MS.	British Museum ("Alert.")
M. radiatum, n. sp.	*Actinometra meridionalis*, A. Ag.?	Kiel Museum.
M. pulvinar, Graff.	*Antedon phalangium*, Müll., sp.	"Porcupine."
M. calycotyle, n. sp.	*Pentacrinus alternicirrus*, P. H. C.	Challenger Expedition.
M. compressum, n. sp.	*Bathycrinus aldrichianus*, Wyv. Th.	Do. do.
M. brevicirrum, n. sp.	*Actinometra mutabilis*, Lütken, MS.	Copenhagen Museum.
M. pictum, n. sp.	*Antedon spinifera*, P. H. C.?	"Blake."
M. nigrescens, n. sp.	*Actinometra morsei*, P. H. C.	Mus. Comp. Zool., Cambridge.

Species of *Myzostoma*.	Host.	Received from.
M. cirriferum, F. S. L.	*Antedon rosacea.*	Many European Localities.
	„ *petasus*, P. H. C.	P. H. Carpenter.
		Kiel Museum.
		"Triton."
	„ *hystrix*, P. H. C.	"Porcupine."
M. crenatum, n. sp.	*Actinometra meridionalis*, A. Ag.?	"Blake."
		Mus. Comp. Zool. ("Investigator").
M. wyville-thomsoni, n. sp.	*Metacrinus costatus*, P. H. C.	Challenger Expedition.
	„ *angulatus*, P. H. C.	Do. do.
M. vastum, n. sp.	*Actinometra japonica*, Müll., sp.	Leyden Museum.
	„ *blakei*, P. H. C.	"Blake."
M. agassizii, n. sp.	*Antedon hageni*, Pourt.	"Bibb."
	„ *spinifera*, P. H. C.?	"Blake."
M. dubium, Graff.	*Antedon triquetra*, Semp., MS.	Prof. C. Semper.
	„ *dubia*, Semp., MS.	Do.
M. mœbianum, n. sp.	*Comatula*, sp.?	Prof. K. Möbius.
M. elongatum, Graff.	*Antedon triquetra*, Semp., MS.	Prof. C. Semper.
M. verrucosum, Graff.		
M. dentatum, n. sp.	*Antedon bidentata*, P. H. C.	Challenger Expedition.
M. fimbriatum, n. sp.	*Antedon eschrichti*, Müll., sp., or	Challenger Expedition.
	„ *quadrata*, P. H. C.	
M. excisum, n. sp.	*Antedon hageni*, Pourt.	"Bibb."
	„ *impinnata*, P. H. C.	Kiel Museum.
M. irregulare, n. sp.	*Actinometra meridionalis*, A. Ag.	"Bibb" and "Blake."
		Copenhagen Museum.
	„ *meridionalis*, var. *carinata*, P. H. C.	"Blake."
M. caribbeanum, n. sp.	Uncertain.	Do

Species of *Myzostoma*.	Host.	Received from.
M. rotundum, n. sp.	*Actinometra meridionalis*, var. *carinata*, P. H. C.?	"Blake."
M. oblongum, n. sp.		
M. abundans, n. sp.	*Actinometra pulchella*, Pourt., sp.	Do.
M. elegans, Graff.	*Antedon triquetra*, Semp., MS.	Prof. C. Semper.
	Actinometra parvicirra, Müll., sp.	Do.
	„ *meridionalis*, A. Ag., sp.	"Bibb."
M. antennatum, n. sp.	Uncertain.	Kiel Museum.
M. cornutum, Graff.	*Antedon triquetra*, Semp., MS.	Prof. C. Semper.
M. brachiatum, Graff.	*Actinometra nigra*, Semp., MS.	Do.
M. fissum, n. sp.	*Antedon inæqualis*, P. H. C.?	Challenger Expedition.
M. intermedium, n. sp.	*Antedon multiradiata*, P. H. C.	Do. do.
M. quadrifilum, n. sp.	*Antedon bidentata*, P. H. C.	Do. do.
M. quadricaudatum, n. sp.	*Antedon fluctuans*, P. H. C.	Do. do.
M. lobatum, Graff.	*Actinometra fimbriata*, Müll.	Prof. C. Semper.
M. bicaudatum, n. sp.	*Actinometra meridionalis*, A. Ag., sp.	"Bibb."
M. filicauda, n. sp.	*Antedon hageni*, Pourt.	"Corvin."
M. filiferum, n. sp.	*Antedon bidentata*, P. H. C.	Challenger Expedition.
M. carinatum, n. sp.	*Antedon impinnata*, P. H. C.	Kiel Museum.
	Actinometra pulchella, Pourt., sp.	"Blake."
M. coronatum, n. sp.	*Bathycrinus aldrichianus*, Wyv. Th.	Challenger Expedition.
M. folium, n. sp.	*Antedon manca*, P. H. C.	Do. do.
M. asymmetricum, n. sp.	*Pentacrinus alternicirrus*, P. H. C.	Do. do.
M. pentacrini, n. sp.		Do. do.
M. deformator, n. sp.		Do. do.
M. cysticolum, n. sp.	*Actinometra meridionalis*, var. *carinata*, P. H. C.	"Hassler."
		"Blake."

Species of *Myzostoma*.	Host.	Received from.
M. tenuispinum, n. sp.	*Antedon inæqualis*, P. H. C.	Challenger Expedition.
	„ *incisa*, P. H. C.	Do. do.
	„ *angusticalyx*, P. H. C.	Do. do.
	„ *basicurva*, P. H. C.	Do. do.
M. willemoesii, n. sp.	*Antedon basicurva*, P. H. C.	Do. do.
	„ *inæqualis*, P. H. C.	Do. do.
M. inflator, n. sp.	*Antedon angustiradia*, P. H. C.	Do. do.
	Actinomeira pulchella, Pourt., sp.	"Blake."
M. murrayi, n. sp.	*Antedon angustiradia*, P. H. C.	Challenger Expedition.
	„ *radiospina*, P. H. C.	Do. do.
	„ *duplex*, P. H. C.	"Blake."
Stelechopus hyocrini, n. g., n. sp.	*Hyocrinus*, sp. ?	Challenger Expedition.

TABLE II.

List of Crinoids on which Myzostomida *have been hitherto found.*

Host.	Species of *Myzostoma*.	Living.
Antedon angusticalyx, P. H. C.	*M. tenuispinum*, n. sp.	In roundish arm cysts.
„ *angustiradia*, P. H. C.	*M. inflator*, n. sp.	In independent sessile cysts.
	M. murrayi, n. sp.	In independent stalked cysts.
„ *basicurva*, P. H. C.	*M. willemoesii*, n. sp.	In spiral malformations of the pinnules.
	M. tenuispinum, n. sp.	In roundish arm cysts.
„ *bidentata*, P. H. C.	*M. dentatum*, n. sp.	Free.
	M. quadrifilum, n. sp.	Do.
	M. filiferum, n. sp.	Do.
„ *carinata*, Leach, sp.	*M. gigas*, Lütken.	Do.

Host.	Species of *Myzostoma*.	Living.
Antedon dentata, Say.	*M. carpenteri*, Graff.	Free.
,, *dubia*, Semp., MS.	*M. dubium*, Graff.	Do.
,, *duplex*, P. H. C.	*M. murrayi*, n. sp.	In independent stalked cysts.
,, *eschrichti*, Müll., sp.	*M. gigas*, Lütken.	Free.
	M. fimbriatum, n. sp. ?	Do.
,, *fluctuans*, P. H. C.	*M. quadricaudatum*, n. sp.	Do.
,, *hageni*, Pourt.	*M. agassizii*, n. sp.	Do.
	M. excisum, n. sp.	Do.
	M. filicauda, n. sp.	Do.
,, *hystrix*, P. H. C.	*M. cirriferum*, F. S. L.	Do.
,, *impinnata*, P. H. C.	*M. excisum*, n. sp.	Do.
	M. carinatum, n. sp.	Do.
,, *inæqualis*, P. H. C.	*M. labiatum*, n. sp. ?	Do.
	M. echinus, n. sp. ?	Do.
	M. fissum, n. sp. ?	Do.
	M. tenuispinum, n. sp.	In roundish arm cysts.
	M. willemoesii, n. sp.	In spiral malformations of the pinnules.
,, *incisa*, P. H. C.	*M. echinus*, n. sp. ?	Free.
	M. tenuispinum, n. sp. ?	In roundish arm cysts.
,, *insignis*, Bell, MS.	*M. coriaceum*, n. sp.	Free.
,, *manca*, P. H. C.	*M. folium*, n. sp.	Do.
,, *multiradiata*, P. H. C.	*M. intermedium*, n. sp.	Do.
,, *palmata*, Müll., sp.	*M. costatum*, F. S. L. ?	Do.
,, *petasus*, P. H. C.	*M. cirriferum*, F. S. L.	Do.
,, *phalangium*, Müll., sp.	*M. alatum*, Graff.	Do.
	M. pulvinar, Graff.	Do.
,, *pourtalesii*, P. H. C.	*M. brevipes*, n. sp.	Do.
,, *quadrata*, P. H. C.	*M. gigas*, Lütken ?	Do.
	M. fimbriatum, n. sp. ?	Do.

Host.	Species of *Myzostoma*.	Living.
Antedon radiospina, P. H. C.	*M. murrayi*, n. sp.	In independent stalked cysts.
„ *rosacea*.	*M. glabrum*, F. S. L.	Free.
	M. cirriferum, F. S. L.	Do.
„ *savignyi*, Müll., sp.	*M. costatum*, F. S. L. ?	Do.
„ *spinifera*, P. H. C.	*M. pictum*, n. sp. ?	Do.
	M. agassizii, n. sp. ?	Do.
„ *tenax*, Lütken, MS.	*M. plicatum*, n. sp.	Do.
„ *triquetra*, Semp., MS.	*M. dubium*, Graff.	Do.
	M. costatum, F. S. L.	Do.
	M. elongatum, Graff.	Do.
	M. verrucosum, Graff.	Do.
	M. elegans, Graff.	Do.
	M. cornutum, Graff.	Do.
Actinometra blakei, P. H. C.	*M. areolatum*, n. sp.	Do.
	M. vastum, n. sp.	Do.
„ *discoidea*, P. H. C.	*M. marginatum*, n. sp.	Do.
„ *fimbriata*, Müll.	*M. lobatum*, Graff.	Do.
„ *japonica*, Müll., sp.	*M. vastum*, n. sp.	Do.
„ *intricata*, Lütken, MS.	*M. lütkeni*, n. sp.	Do.
„ *jukesi*, P. H. C.	*M. horologium*, n. sp.	Do.
„ *lineata*, P. H. C.	*M. testudo*, n. sp.	Do.
„ *meridionalis*, A. Ag., sp.	*M. radiatum*, n. sp. ?	Do.
	M. crenatum, n. sp. ?	Do.
	M. irregulare, n. sp.	Do.
	M. elegans, Graff.	Do.
	M. bicaulatum, n. sp.	Do.
„ *meridionalis*, var. *carinata*, P. H. C.	*M. irregulare*, n. sp.	Do.
	M. rotundum, n. sp. ?	Do.
	M. oblongum n. sp. ?	Do.
	M. cysticolum, n. sp.	In independent sessile cysts on the pinnules and on the ambulacral side of the arms.

Host.	Species of *Myzostoma*.	Living.
Actinometra meridionalis, var. *quadrata*, P. H. C.	*M. areolatum*, n. sp.	Free.
„ *morsei*, P. H. C.	*M. nigrescens*, n. sp.	Do.
„ *mutabilis*, Lütken, MS.	*M. echinus*, n. sp.	Do.
	M. brevicirrum, n. sp.	Do.
„ *nigra*, Semp., MS.	*M. brachiatum*, Graff.	Do.
„ *parvicirra*, Müll., sp.	*M. costatum*, F. S. L.	Do.
	M. pallidum, Graff.	Do.
	M. triste, Graff.	Do.
	M. elegans, Graff.	Do.
„ *pulchella*, Pourt., sp.	*M. abundans*, n. sp.	Do.
	M. carinatum, n. sp.	Do.
	M. inflator, n. sp.	In independent sessile cysts.
„ *solaris*, Lam., sp.	*M. pallidum*, Graff.	Free.
„ *strata*, P. H. C.	*M. horologium*, n. sp.	Do.
Comatula, sp.?	*M. mœbianum*, n. sp.	Do.
Pentacrinus alternicirrus, P. H. C.	*M. calycotyle*, n. sp.	Do.
	M. asymmetricum, n. sp.	Sticking fast to and enlarging the pinnules.
	M. pentacrini, n. sp.	In swellings on the arms.
	M. deformator, n. sp.	Inside the pinnules, which become swollen and ovoid.
Bathycrinus aldrichianus, Wyv. Th.	*M. compressum*, n. sp.	Free.
	M. coronatum, n. sp.	Do.
Metacrinus costatus, P. H. C.	*M. wyville-thomsoni*, n. sp.	Do.
„ *angulatus*, P. H. C.	*M. wyville-thomsoni*, n. sp.	Do.
Hyocrinus, sp.?	*Stelechopus hyocrini*, n. g., n. sp.	Do.

It appears from the two foregoing lists that the sixty-eight species of Myzostomida are distributed upon fifty-two hosts in the following manner :—

48	species	have	each	1 host.
13	„	„	„	2 hosts.
6	„	„	„	3 hosts.
1	„	„	„	4 hosts.

In those cases, however, where one species infests more than one host, the latter are always closely allied, and in no case is there an instance of a single species of this parasite being found both upon a stalked Crinoid and one that has no stalk.

With regard to the number of different species of Myzostomida that are found upon a single host it appears that

31	species of	Crinoidea	are infested by	1	species of	*Myzostoma*.
12	„	„	„	2	„	„
3	„	„	„	3	„	„
3	„	„	„	4	„	„
2	„	„	„	5	„	„
1	„	„	„	6	„	„

Systematic Remarks.

The definition of the group Myzostomida, which I place as an Order in the Class Stelechopoda (Genus Myzostoma, p. 71), must be altered to admit the new form *Stelechopus hyocrini* (see, special description); this species has a straight alimentary canal and no suckers nor male genital apertures. There are also other forms that are more certainly diœcious.

Order Myzostomida.—Symmetrical non-segmented animals, provided with an external chitinous cuticle, five pairs of movable parapodia, each with a hook and supporting rod, an alimentary canal with oral and anal apertures; through which latter the eggs are extruded. Diœcious or hermaphrodite; central nervous system consisting of an oblong mass situated beneath the intestine, and giving off two branches in front which encircle the pharynx, but bear no ganglia, and several other pairs of lateral nerves. No circulatory, respiratory, nor excretory organs. Parasitic on and in Crinoids.

Family I. *Stelechopidæ*.—Myzostomida with straight alimentary canal; parapodia independent of each other; no internal muscular septa. Suckers absent. Probably hermaphrodite, sexual products reaching the exterior through a cloaca.

Family II. *Myzostomidæ*.—Myzostomida with ramified alimentary canal, parapodia connected by muscles which converge to a central muscular mass. Body

cavity divided into paired chambers by incomplete septa. Usually four pairs of suckers. Hermaphrodite or dicœcious. Ova evacuated through a cloaca, male generative apertures situated laterally.

Of the first Family we have at present but one representative; the second Family contains sixty-seven species. I have, however, been unable to classify them in a satisfactory manner, chiefly because, as has been already mentioned, the state of preservation of many of the individuals rendered it impossible to make out with any certainty the structure of various organs important for systematic purposes. I could not, for example, ascertain whether all the free-living species were really hermaphrodite, as I should have been obliged to destroy several unique specimens in order to determine whether the testes were present or not. If this point had been placed beyond a doubt, I should have divided the second Family into two groups—(*a*) hermaphrodite forms; (*b*) dicœcious forms. In the same way with many other secondary characters,—such as the presence or absence of suckers, the muscular septa, &c.,—it was impossible to make a thorough investigation.

The following Table of Species, therefore, is given only for use in the determination of species. No doubt when more abundant material has been examined it will be possible to give a generic sub-classification of the Family Myzostomidæ.

Table of Species.

I. With ramified intestinal canal. Family Myzostomidæ, genus *Myzostoma*.
* Free-living, not forming cysts (mostly with suckers).
** Mouth terminal or ventral.
*** Without caudal appendages.
**** With distinct suckers.
***** Border of the disk quite smooth.
Border of the mouth covered with papillæ, . . . *M. labiatum.*
Border of the mouth without papillæ.
Back with radial series of hard tubercles, . . . *M. echinus.*
Back without tubercles.
Parapodia long, placed near the border.
Back two-coloured, ... *M. horologium.*
Back one-coloured.
Skin of the back light yellow, with tubercles, . . *M. longipes.*
Skin of the back grey-brown, areolated, . . *M. chinesicum.*
Parapodia short, nearer to the centre, . . . *M. alatum.*
***** Border of the disk irregularly toothed.
Body oblong, extended, with few obtuse ribs, . . . *M. rubrofasciatum.*
Body circular.
With numerous sharp-edged ribs, ... *M. plicatum.*
With numerous obtuse ribs, ... *M. costatum.*

* * * * * Border of the disk with cirri.
* * * * * * Ten cirri on each side.
* * * * * * * Cirri very short, body stout and opaque; mostly very big, with a vaulted back.
Body oblong, extended, with a keel-like back, laterally compressed, ... *M. compressum.*
Body disk-like.
Body much longer than broad, flat above and below, . *M. areolatum.*
Body circular, length and breadth equal, or nearly equal.
Central muscle-mass striking:
Occupying the whole border of the belly; back flat, . *M. radiatum.*
A marginal zone free; back vaulted.
Back covered with warts, ... *M. marginatum.*
Back irregularly areolated, without warts, . . *M. lütkeni.*
Central muscle-mass not striking.
With a distinct hyaline marginal border.
Parapodia small, lying in small cavities, . . *M. brevipes.*
Parapodia well-developed, freely projecting, . . *M. pallidum.*
A hyaline marginal border not existing.
With five pairs of dorsal elevations, . . . *M. testudo.*
Back without elevations.
Parapodia very feeble, quite close to the border, . *M. carpenteri.*
Parapodia well-developed, removed from the border.
Cirri distinct, many times longer than broad.
Body very big and massive, back with scattered tubercles, ... *M. gigas.*
Body of insignificant size, without warts.
Diameter of more than 9 mm.; parapodia in the first third of the radius, . . *M. coriaceum.*
Scarcely half as big; parapodia in the middle between centre and border, . . *M. triste.*
Cirri reduced to insignificant warts, . . *M. glabrum.*
* * * * * * Cirri (mostly) long; body generally a thin, transparent, delicate plate.
Middle part of the body two-coloured, ... *M. pictum.*
Middle part of the body one-coloured.
The whole body opaque, stout, black-brown, . . . *M. nigrescens.*
The whole body, or at least the border, pellucid, delicate.
With marginal fringes besides the cirri, . . . *M. fimbriatum.*
Without marginal fringes.
Hind end deeply intersected, ... *M. excisum.*
Hind end bordered, rounded.
Cirri reduced to warts, ... *M. brevicirrum.*
Cirri well-developed, long.
Cirri much different in length (the first and tenth pairs often longer than the others), . . *M. antennatum.*
Cirri not much different.
Border notched, ... *M. crenatum.*
Border not notched.
Cirri ending in fine points, . . . *M. agassizii.*

Cirri with obtuse points.
Parapodia slit, ... *M. wyville-thomsoni.*
Parapodia not slit.
Body rounded, length of the cirri often greater than the breadth of the border, *M. vastum.*
Body oval; cirri somewhat greater than the breadth of the marginal border, . *M. cirriferum.*

* * * * * * More than ten cirri on each side.
Cirri as large obtuse flaps, nearly as broad as long.
Central disk prominent on the ventral side, . . . *M. verrucosum.*
Central disk not prominent, ... *M. dentatum.*
Cirri normal, lessened at the point.
Body much longer than broad.
Cirri sharply separated from the border.
Some pairs of the cirri extraordinarily elongated.
The first pair alone elongated, ... *M. cornutum.*
More (five to six) pairs elongated, . . . *M. brachiatum.*
No cirri of an extraordinary length.
Suckers quite near the border, . . . *M. oblongum.*
Suckers moved from the border, more than the breadth of the suckers, ... *M. caribbeanum.*
Cirri with a large base rising gradually out of the border.
Intestine much ramified, ... *M. elongatum.*
Intestinal branches not very numerous, . . . *M. mœbianum.*
Body circular, not, or not much, different in length and breadth.
On each side not more than twenty cirri.
Cirri sharply separated from the border, . . . *M. irregulare.*
Cirri with a large base, rising gradually out of the border, *M. dubium.*
More than twenty cirri on each side.
Cirri ending in very fine points, ... *M. elegans.*
Cirri ending obtusely.
Suckers round, parapodia feeble and small, . . *M. rotundum.*
Suckers oblong, parapodia vigorous and big, . . *M. abundans.*

* * * * Suckers are wanting.
Border irregularly notched; back smooth, ... *M. folium.*
Border with ten pairs of cirri, back areolated, . . . *M. coronatum.*
Border with more than twenty cirri, back ribbed, . . . *M. carinatum.*

* * * With caudal appendages.
Two caudal appendages existing.
Caudal appendages without terminal threads, . . . *M. bicaudatum.*
Caudal appendages with terminal threads.
Terminal thread shorter than the base of the caudal appendages, . *M. filicauda.*
Terminal thread longer than the base of the caudal appendages, . *M. filiferum.*
Four caudal appendages existing.
Caudal appendages large and flat, with a notched lateral border, . *M. lobatum.*
Caudal appendages round.
Caudal appendages without terminal threads, . . . *M. quadricaudatum.*
Caudal appendages with terminal threads, ... *M. quadrifilum.*
Six caudal appendages existing.
Caudal appendages large and flat, without terminal threads, . . *M. fissum.*

Caudal appendages round, with terminal threads, . . .	*M. intermedium.*
Mouth (and cloaca) dorsal.	
With large, prominent, ventral elevation, without suckers, . .	*M. pulvinar.*
Body thin, without central elevation, with stalked suckers, . .	*M. calycotyle.*
Living in cysts or forming malformations of the pinnules, without suckers.	
Living on the pinnule which becomes enlarged on the ventral side, . .	*M. asymmetricum.*
Living in the interior of cysts.	
Androgynous, all individuals equally formed.	
Border with cirri, cysts as thickenings of the arms, . . .	*M. pentacrini.*
Border without cirri, cysts as swollen pinnules, ...	*M. deformator.*
Sexes separated, large female and dwarf male individuals.	
Cysts as intumescences of the arm-joints (border of the body with cirri), ...	*M. tenuispinum.*
Cysts as spirally rolled-up pinnules (border of the body with cirri), .	*M. willemoesii.*
Cysts as independent new formations of the skin of the host (border of the body without cirri).	
Female often thicker in the middle than in the lateral parts, cysts not stalked, ...	*M. cysticolum.*
Female of uniform thickness, cysts mostly stalked.	
Male with ramified testis, ...	*M. inflator.*
Male with compact testis, ...	*M. murrayi.*
II. Intestine straight, not ramified (without suckers). Family and genus *Stelechopus*, only one species, ...	*St. hyocrini.*

To this table I may be permitted to add some remarks about the natural affinities of the different species. The starting-point of the whole group is doubtless the Tardigrade-like form *Stelechopus hyocrini*. From some form like this *Myzostoma folium* has been developed; it is characterised by an extended worm-like body, the absence of suckers, and by an arrangement of the parapodia, similar to that of *Stelechopus*. The ancestral form, however, had in all probability muscular septa placed at right angles to the long axis of the body and not radially. Out of these other elongated forms with suckers were developed, which in their turn gave rise to the more discoid species.

A greater or less degree of mobile power may have produced the two different groups already alluded to, one of which is distinguished by its thin body and hyaline marginal portion, by the feeble development of the parapodia and their enclosed structures, and by the length of the cirri; the other by the massive form of its body, and by the great development of parapodia and muscles, and the short cirri, which are sometimes altogether absent.

In some species of the second group the change in position of the cloaca (*Myzostoma alatum* and *Myzostoma glabrum*), or of mouth and cloaca (*Myzostoma pulvinar* and *Myzostoma calycotyle*) to the dorsal surface, is to be looked upon as having been produced by the firm attachment of the parasite to the skin of its host by the great development of parapodia and suckers.

In the first group we find differences in the number of the cirri, some having twenty,

and some an unlimited number; the former appear to me to be the most specialised forms. The Myzostomida Caudata with the caudal appendages have originated from discoid forms (see p. 8), in which some of the cirri have taken on a special development, whereas the Myzostomida Cysticola would seem to be retrograde forms, from the absence of suckers and the rudimentary radially arranged parapodia, as well as from the presence of muscular septa and the central convergence of the parapodial muscles. They have probably originated partly from the stout sessile species and partly from the more delicate free living species, as shown by the fact that the cirri are sometimes entirely absent (*Myzostoma cysticolum*), and sometimes, on the other hand, highly developed (*Myzostoma willemoesii*) in both sexes. The last-mentioned species is also remarkable from the fact that both sexes possess well-developed suckers, and shows therefore a less degree of degeneration than the other cysticolous forms; also the male has the typical ramified form of the testis found in the free living species, and not the compact rounded organ of the other Myzostomida Cysticola.

DESCRIPTION OF SPECIES.

Myzostoma, F. S. Leuckart.

1. *Myzostoma horologium*, n. sp. (Pl. I. figs. 1–17).

This form, of which I was able to investigate a great number of examples, closely resembles our European form, *Myzostoma glabrum*, but has not the central muscular mass so highly developed. The dorsal surface is generally flat or somewhat vaulted and bent upwards at the margins. The diameter of the body in the largest specimen was 6 mm. The skin of the back has no conical papillæ like those of *Myzostoma glabrum*, but merely some irregular wrinkles, and these only in large specimens. Cirri are entirely wanting. The pigment is arranged in much the same fashion as in *Myzostoma glabrum* (*cf.*, Genus Myzostoma, pl. i. figs. 2–10), but there is only a single median longitudinal line instead of two, which, however, differs considerably in different individuals. The typical coloration is shown in fig. 4; it resembles very much the dial of a watch divided into ten parts with two large hands. The central point of the dorsal surface is generally a little depressed and devoid of pigment, and is but rarely extended lengthways or provided with a central pigment spot. There are also four pairs of pigment spots on the margin corresponding to the suckers. The most frequent modification of this is shown in fig. 5, where it will be seen that there is an additional mass of pigment at each end of the median line, and that each of the marginal lines of pigment is divided into two parts. In the specimen displayed in fig. 9 the pigment is removed from the border of the body. On account of the lateral continuations of the marginal lines, this individual forms a transition to the varieties represented in figs. 6–11, which are characterised by the great quantity of pigment present, as well as by the unilateral or symmetrical anastomosis of the marginal lines with each other and with the median line. Figs. 7, 8 are the extremes of these dark coloured forms; fig. 8 shows a number of supernumerary spots, and a black border round the whole dorsal surface. There are also other varieties but slightly pigmented (figs. 12–14), with an incomplete median line and without some of the marginal lines. One of the most aberrant modifications is shown in fig. 13; the light central point is wanting in this form, and the coloration is asymmetrical.

The spirit specimens of *Myzostoma horologium* that I have in my possession vary in their ground-colour from white or sulphur-yellow to a dark brownish-yellow. Von

Willemoes Suhm has described the colour of this species in the living state[1] as being white with black spots. The black pigment I discovered by transverse sections to be placed in a layer beneath the epidermis, intersected by fibrils which are especially developed on the dorsal side, and indeed disappear entirely on the ventral side (fig. 3, *cu.*). The ventral side (figs. 1, 2) is of an even brownish tint, and shows a central elevation corresponding to the ventral ganglion and central muscular mass, with its continuations towards the mouth (*m.*) and cloaca (*cl.*), and radial elevations corresponding to the muscle bundles which run from the central muscle mass to the parapodia (*p.*) and suckers (*s.*).

The parapodia (*p.*) are highly developed, and placed close to the external margin, in consequence of which their extremities are to be seen from above. The hooks (fig. 15) are very strong, measuring ·17–·22 mm. in length, and up to ·03 mm. in thickness; the tip is bent at a right angle. The column of the manubrium is very short (fig. 16), not much more than half as long as the hook. The manubrium (*ma.*) is highly developed, and made up of three shovel-shaped prongs.

The suckers (*s.*) are placed between the bases of the parapodia and the margin of the body; sometimes they project considerably, but are usually depressed as shown in fig. 3, where the sucker occupies half the thickness of the body, and is entirely retracted into its sheath (*s.*). The epithelium covering the sucker (*se.*) is markedly thicker than that over the rest of the body (*e.*). The free margin of the sucker has in some individuals a crown of brownish papillæ, which are also occasionally found upon the parapodia. Viewed with a lens they look like chitinous spicules, but are really only elevations of the integument coloured brown by the enclosed pigment. In some individuals these structures can be seen with the naked eye, in others the papillæ appear to be absent or present, but without any pigment. The pharynx is relatively small, and the mouth (*m.*), also small, is some way removed from the margin of the body. The obtusely-conical cloacal papilla (*cl.*) is placed immediately beneath the hinder end of the body. This ventral situation of the cloaca is the most remarkable difference between this species and *Myzostoma glabrum*.

The sexual organs resemble those of the last-mentioned species, and the young are attached to the body of the adult in the same way (see Genus Myzostoma, p. 63).

The diffuse brown coloration of the young specimens is remarkable, resembling that of some adult specimens of *Myzostoma glabrum* (*loc. cit.*, pl. i. figs. 3, 4).

Host.—Uncertain. Dredged by Challenger Expedition at Stations 186, 187 (Cape York). The specimens, according to the notes of P. H. Carpenter, most probably come

[1] "In der Arafura-See habe ich im vorigen Jahre einmal 80 Exemplare einer grossen Comatula untersucht und fand circa auf jeder zehnten unsere Schmarotzer. Es ist das das grösste Myzostomum, das ich je gesehen habe. Sie sassen oder krochen schlängelnd auf den Kelchen, selten in der Rinne der Arme. Meist fanden sich 2–3 grosse Thiere und mit ihnen ein kleineres. Alle diese Myzostomen waren, wie die Comatula, weiss und schwarz gefleckt, und die übrigen zahlreichen Schmarotzer des Thieres zeigten dieselbe Färbung."—Von der Challenger-Expedition, Brief VI. *Zeitschr. f. wiss. Zool.* Bd. xxvi. p. lxxix.

from *Actinometra jukesi*, P. H. C., and *Actinometra strata*, P. H. C., the first of which was found exclusively at Station 187, the latter at both Stations. Some specimens sent to me by Sir Wyville Thomson were labelled "Myzostomum from disk of *Phanogenia*" (probably = *Actinometra jukesi*, P. H. C.).

2. *Myzostoma longipes*, n. sp. (Pl. II. figs. 24–28).

The single specimen that I had measures nearly 2 mm. in diameter. It is ochre-coloured, and the flat margin is without cirri and bent upwards so that the animal is quite plate-shaped (see ideal section, fig. 27). The dorsal surface is covered with minute warts especially developed in the centre, where they are separated from each other by deep furrows; on the lateral parts of the dorsal surface they are smaller and closely adpressed. Towards the margin, which is hardly at all transparent, they disappear. The thickness of the body is in relation to the great development of the muscles; there is the large central elevation with the radial ridges on the ventral side (fig. 25). The fibrils of the parapodial muscles may be distinctly seen with a lens through the wall of the body. The basal portions of the parapodia occupy about the middle third of the radius from the central muscular mass to the margin of the body. The free ends of the parapodia extend beyond the margin of the body, and may be seen from the dorsal surface (fig. 24). The parts of the hook-apparatus (fig. 28) are extremely short, but very thick and stout. The tip of the hook is slightly bent, and is ·09 mm. long; the greatest thickness at the base is ·02 mm. The manubrium (*ma.*) is ·05 mm. long, and increases in size at the free end into an obtuse shovel-like manubrial plate, which occupies more than one-third of its whole length.

The muscles of the suckers, like those of the parapodia, are well developed, and the suckers themselves are large and distinct.

The mouth is sub-terminal; the pharynx is provided with finely serrated walls (*ph.*). The cloacal papilla is on the hind margin of the ventral side.

Host.—Uncertain. Dredged by the "Blake" Expedition at Station 269 (St. Vincent).

3. *Myzostoma chinesicum*, n. sp. (Pl. II. fig. 31).

This species belongs to the Godeffroy Museum at Hamburgh, and I obtained it through the kindness of Dr. J. W. Spengel. It resembles closely *Myzostoma horologium* in size and thickness of body, and like the latter has the dorsal surface flattened and its margins turned up; the majority of specimens—unlike that shown in fig. 31—display a circular contour. The diameter of the disk is 2·4 mm.; there are no cirri, and the parapodia and suckers are without the tubercles seen in *Myzostoma horologium*. The parapodia have a number of circular wrinkles, and the suckers show a beautiful radial folding; the male genital papillæ of some individuals are nearly as prominent as in *Myzostoma gigas*. The main feature of this species consists in the uniform brownish-grey colour of the back

and ventral surface, which sometimes inclines to green. The back is divided by a series of furrows into polygonal areas, which are continued for a short way on to the ventral surface.

Host.—Uncertain. Dredged in the Chinese Sea.

4. *Myzostoma labiatum*, n. sp. (Pl. II. fig. 23).

This species is not unlike *Myzostoma lütkeni*, but differs from it in that the ventral elevation does not differ in colour and consistency from the rest of the ventral surface, and that the parapodia (*p.*) and suckers (*s.*) are further out.

The suckers also are smaller than in *Myzostoma lütkeni*, and have a finely papillose margin.

The uniformly greyish-brown body is somewhat more than 4 mm. in diameter; it is circular and unprovided with cirri. On the dorsal surface is a median elevation, and on each side five elevations corresponding to the parapodia. On the ridges formed by these latter the folds, which are developed over the whole body both above and below, take the shape of small wart-like processes. The pharynx (*ph.*) is distinctly visible, with the crown of papillæ, and makes the resemblance to *Myzostoma lütkeni* still more obvious. A closer examination shows that these papillæ (fifteen to be seen from the ventral side, the longest measuring ·3 mm.) belong really not to the pharynx but to the margin of the mouth, and therefore at once serve to distinguish this species. The conical cloacal papilla is very prominent, and lies at the same distance from the margin as the suckers.

Host.—Probably *Antedon inæqualis*, P. H. C. Dredged by the Challenger Expedition at Station 174, south-west of the Fiji Islands.

5. *Myzostoma echinus*, n. sp. (Pl. II. figs. 29–30).

This is one of the most remarkable species, owing to its size and the sculpturing of the back. The body is nearly hemispherical, with a flat ventral side of 5 mm. diameter. The back is grey inclining to brown, and very finely folded to form irregular lines, which are conspicuous and visible even with a simple lens. The dorsal surface is also ornamented by high cylindrical tubercles of a brown colour and considerable hardness. These tubercles bear smaller tubercles upon them, which are sometimes ramified. The arrangement of these tubercles corresponds to the structural arrangement of the body. First there is a median rank, running from the anterior to the posterior end of the body; on either side of this are five longer rows, each containing seven to ten tubercles and corresponding to the parapodia; between them are shorter lines containing three to five smaller tubercles, which correspond to the suckers. Occasionally several tubercles of one row are joined by continuous ridges of the colour and consistence of the tubercles themselves. The flat ventral surface is folded (fig. 30) like the back, but the smaller folds are not so distinctly

visible. The parapodia (*p.*) are proportionately small, but not so small as they are represented in fig. 30, and are placed in a circle occupying the middle of the body; each parapodium has a basal portion and a smaller terminal portion. The suckers are placed a little to the outside of the parapodia. They are prominent and hemispherical in form and radially furrowed. The margin of the mouth (*ph.*) is prolonged beyond the surface of the body into a small tube equal in height to the suckers; a number of papillæ belonging to the pharynx project from its aperture. The large cloacal papilla (*cl.*) lies in the middle between the parapodia and the margin of the body. The latter is provided with probably twenty short tubercle-like cirri.

Besides this specimen, collected during the Challenger Expedition, I have another individual from the Copenhagen Museum, which is no doubt a younger stage of the same species. It is only 3 mm. long, of a uniform greyish-brown tint, with all the characteristic markings present though not so distinct. The rows of tubercles on the back are far smaller, and can only be seen by the help of a lens; also they do not differ in colour and consistency from the rest of the skin of the back.

Hosts.—(*a*) Probably *Antedon incisa*, P. H. C., or *Antedon inæqualis*, P. H. C., from Station 174 of Challenger Expedition (south-west of the Fiji Islands).

(*b*) *Actinometra mutabilis*, Lütken, MS., from the Copenhagen Museum. Dredged by Captain Andréa in 17 fathoms; lat. 23° 20′ N., long. 118° 30′ E.

6. *Myzostoma alatum*, Graff (Pl. I. figs. 25–29).

Myzostoma alatum, Graff, Proc. Roy. Soc. Edin., vol. xii. p. 379.

I have named this species from the character of the marginal part of the body, which is not unlike the "wings" of certain fruits, *e.g.*, of the elm. This comparison is rendered more striking by the fact that the animal is longer than broad, and slightly notched at the middle of the anterior and posterior margins. Behind the anterior notch is a small cavity with five pairs of depressions; this was caused by the presence of a young individual (fig. 25), which unfortunately was lost. Fig. 28 represents an ideal transverse section, and it may be seen that the central part of the body, strongly convex above, is much thicker than the marginal part, though the latter is not thin enough to be transparent, and there is no defined marginal border. The larger specimen is 3 mm. long, and the smaller 2 mm. The colour of the back is a dirty yellow, inclining to grey upon the ventral surface. The skin of the back is covered by numerous minute conical papillæ, whereas the ventral surface is quite smooth. The parapodia are situated at the periphery of the central elevation (figs. 26, 27); they are extremely small, and consist merely of a circular fold, out of the middle of which projects the brownish-black tip of the hooks. The latter (fig. 29) are only ·09 mm. long, and ·013 mm. broad, but I am not confident of the accuracy of these measurements, since I did not remove the hooks

for fear of damaging the specimen too much. They are distinguished by being strongly bent, and by the blackish colour of the tip. The manubrium (*ma.*) is similar to that of *Myzostoma gigas* (Pl. II. figs. 4, 6), but is not so large in proportion. The round well-developed suckers are without the circle of parapodia, and distant from the margin of the body by only one-sixth of the entire radius. The free ends of the suckers of the smaller individual are more extended, and reach beyond the margin of the body; they are goblet-shaped, and larger than the parapodia.

The pharynx is half drawn out and well-developed; the mouth lies as far from the margin of the body as the suckers. The cloacal aperture is dorsal, and lies on a papilla situated just anteriorly to the hinder margin of the body.

Host.—*Antedon phalangium*, Müll., sp. Dredged in the Minch, August 14, 1869, and at Station 13 (off Duncansby Head) (1870), lat. 40° 16′ N., long. 9° 37′ W., in 220 fathoms, by the "Porcupine" Expedition.

7. *Myzostoma costatum*, F. S. Leuckart.

Myzostoma costatum, Graff, Genus Myzostoma, p. 11, pl. i. figs. 13, 14.

Professor Hæckel obtained another specimen of this form at Tur near Sinai, which is rather smaller than the examples previously described by me, and of a slightly different form. It measures nearly 2 mm. in length, the lateral parts are bent ventrally and not obliquely sloped from the middle elevation of the back. The breadth is rather greater than the length; the marginal notches are more distinct, the colour yellowish-brown. The "ribs" are not so distinct as in the specimens from Bohol; the anterior notch is not so marked.

Hosts.—(*a*) *Comatula multiradiata*, Lam. (many types have been confused under this name, the host may be either *Antedon savignyi*, Müll., sp., or *Antedon palmata*, Müll., sp.), Red Sea.

(*b*) *Antedon triquetra*, Semper, MS., Bohol (Philippines).

(*c*) *Actinometra parvicirra*, Müll., sp., Bohol (Philippines).

8. *Myzostoma plicatum*, n. sp. (Pl. III. figs. 16–18).

The body is 4 mm. long and circular in shape, but the true form is somewhat concealed by the sides being turned down. The back is sepia brown, and sculptured in a very characteristic manner. Instead of a longitudinal elevation, there is a furrow running along the length of the back; several furrows also run across this, from one side to the other. There are a number of crest-like elevations corresponding to the intestinal cæca; these elevations cause the marginal part of the body to appear stouter than the central (fig. 18). The thickness of the body is somewhat intermediate between that of *Myzostoma cirriferum* and *Myzostoma glabrum*. The whole disk is opaque, and the only

peculiarity of the marginal portion consists in the obtuse prong-like endings of the radial elevations. The skin of the back is finely granular, and has a few scattered tubercles. The ventral side is smooth and greyish-brown coloured. Fig. 17 shows the arrangement of the relatively feeble parapodia (*p.*), as well as of the suckers (*s.*), mouth (*m.*), and cloacal aperture (*cl.*).

Host.—*Antedon tenax*, Lütken, MS., from New Holland, Copenhagen Museum.

9. *Myzostoma rubro-fasciatum*, n. sp. (Pl. II. fig. 32).

The single individual of this species that I have examined I owe to the kindness of Prof. E. Hæckel. The body is 3 mm. long and rather stout, the greatest breadth is 1·7 mm. The body diminishes in breadth towards what I believe to be the anterior extremity, and is only 1·2 mm. in diameter at the region of the second pair of parapodia. The five pairs of parapodia are rather feebly developed, and arranged in two lines equally distant from the margin and centre of the body. The parapodia show no traces of a division into a basal and distal half; the most anterior pair project in front of the margin of the body, while the hindermost pair are removed from the hind margin by about one-third of their length. The length of the parapodia is as much as ·5 mm. Suckers appeared to be present, but I could not make certain of this. Mouth and cloacal aperture are probably terminal, and lie on the ends of two small papillæ, by which the two extremities of the body are distinguished.

The ventral surface is yellowish in colour, flat and finely wrinkled; the dorsal surface, on the contrary, is coloured and sculptured in so marked a way that it is impossible to confound this species with any other. The central elevation is well-marked, especially in the posterior half; it is joined to eight pairs of lateral elevations, ending at the margin of the body in obtuse notches; between these are here and there indications of secondary elevations, which commence in obtuse prongs, but are not prolonged far towards the centre. The last pair of lateral elevations are continued into two tentacle-like structures, which measure ·6 mm. from base to tip. The animal is also readily distinguishable by its colour. Two dark-red bands run on either side of the median elevation from one end of the body to the other; two less brightly coloured bands run near the lateral margins of the body. There are no tubercles nor cirri present.

Host.—Uncertain. Obtained by Prof. Hæckel at Tur near Sinai, in the Red Sea.

10. *Myzostoma glabrum*, F. S. Leuckart.

Hitherto found in the European seas, but only on *Antedon rosacea* (*Comatula mediterranea*, Lam.), *cf.* p 12, and Genus Myzostoma.

11. *Myzostoma gigas*, Lütken (Pl. II. figs. 1–8).

Myzostoma gigas, Lütken, MS.
„ „ Graff, Proc. Roy. Soc. Edin., vol. xii. p. 378, 1884.

In the year 1877 I received from Dr. Lütken some Myzostomida from the Copenhagen Museum, which on account of their large size had been named by him *Myzostoma gigas*.[1]

This species measures 7 mm. in diameter, the thickness of the body reaching 1·5 mm. in the middle; the back is convex, increasing gradually from the margin, and the animal appears therefore lenticular; the ventral surface is flat. At the extreme edge the body is transparent, and becomes more and more opaque towards the centre. The dorsal surface is covered with tubercles, distinguishable by the naked eye, and separated from each other by intervals (fig. 3), which become smaller and smaller, and finally disappear at the margin of the body. The latter is provided with twenty long, equal cirri, measuring ·16–·2 mm., and arranged at equal distances from each other, except the first pair, which are rather further removed from each other than the succeeding cirri. Each cirrus arises in a small marginal notch. The parapodia (figs. 1, 2, *p.*) are stout, and arranged in a circle at equal distances from the centre and the periphery. Each parapodium has a number of annular furrows and a strong terminal hook-apparatus. The hooks, which are furnished with a fine somewhat bent tip (figs. 4, 5, 6, *u.*), are from ·2–·26 mm. long, and ·01–·02 mm. thick. The manubrium (*ma.*) is a convex plate, with five or six digitiform processes on its free margin. The inequality in length between the stalks of the manubria is very striking. Two of them taken from the same individual measure respectively ·26 and ·15 mm. in length. The suckers (*s.*) are hemispherical, and very large, and situated between the insertions of the parapodia and the margin of the body; they bear a number of incisions round the edge. The pharynx (*ph.*) is small in proportion to the body; the mouth (*m.*) and cloacal papilla (*cl.*) lie at the same level as the suckers, at a considerable distance from the margin.

The male genital papilla (♂) is also remarkably large. All the other specimens that I have are much smaller than those from the Copenhagen Museum, and differ also in their colour, which varies from light yellow to red-brown. The margin of some of the smaller specimens is also more transparent and more marked off from the rest of the disk, especially in a specimen from the Amsterdam Museum, collected during the Dutch Arctic Expedition, which comes nearest in size to the specimens in the Copenhagen Museum. The smallest specimens of all were gathered during the Challenger Expedition. One of these is displayed in figs. 7, 8; it was taken at Bahia, from *Antedon carinata*, and is of a

[1] Dr. Chr. Fr. Lütken, A revised Catalogue of the Annelida and other not Entozoic Worms of Greenland, p. 178, No. 120, *Myzostoma gigas*, Ltk. (MS.), in Manual of the Natural History, &c., of Greenland, edited by Prof. T. Rupert Jones, for the use of the Arctic Expedition, London, 1875.

brownish-yellow colour. Not only is the marginal area of these specimens more transparent, but also the skin of the back, from absence of pigment, and the base of the hook-apparatus is plainly visible through it. This specimen, which is 2·5 mm. long, has an oblong cavity in the middle of the back, from which radiate a number of fine furrows, separating the parapodial sectors from each other. The dorsal tubercles are visible, but much smaller than in the larger individuals. In another specimen also from *Antedon eschrichti* (Station 48), 1·6 mm. long, the dorsal tubercles were scarcely visible, even with a lens.

Hosts.—(*a*) *Antedon eschrichti*, Müll., sp., from north Greenland (Prövén), found in 50 fathoms, by the late Director Olrik, Copenhagen Museum.

„ „ from Jan-Meyen, by Norwegian Arctic Expedition, Bergen Museum.

„ „ "Porcupine," 1869, 60° 14′ N., 6° 17′ W., 632 fathoms. The specimen could not with certainty be set down as *Myzostoma gigas*.

„ „ from 76° 51′ N., 44° 20′ E., 145 fathoms; Station 21 (September 7th) of the Dutch Arctic Expedition.

„ „ or *Antedon quadrata*, P. H. C. Station 48 (Le Have Bank) of the Challenger Expedition.

„ „ from 74° 71′ 4″ N., 50° 23′ E., 84 fathoms; Station 21 (July 7th) of the Dutch Arctic Expedition.

(*b*) *Antedon carinata*, Leach, sp., Bahia, Challenger Expedition.

12. *Myzostoma testudo*, n. sp. (Pl. I. figs. 18–24).

I examined two specimens of this species; one measured 4 mm. in length, the other 2·5 mm.

The larger individual has much the appearance of an oval thickish plate, the margin of which is bent ventrally in such a manner that the animal appears of a convex lenticular shape from above, and concave from below. Its colour is a light sepia brown; the back is sculptured in two different ways, being covered by a number of small tubercles, and also divided by furrows into larger areas, so that it has much the appearance of tortoise-shell. Two longitudinal furrows enclose a central area (figs. 18, 19), which gradually dies away, but again increases at the hinder margin of the body, the latter portion being separated off from the rest by a furrow; this middle area has the appearance of a goblet with a broad base. There are also on either side five oval elevations arranged in a semicircle; these look at first sight as if they were ten small individuals, but a closer examination shows that they are merely elevations, covering the basal ends of the hook-apparatus (*cf.* Genus Myzostoma, pl. viii. fig. 2). There are twenty cirri present, each of which is

situated in a shallow excavation on the margin of the body. The ventral surface is sculptured like the dorsal into polygonal areas, which are, however, irregular in size and form. The central muscular mass is marked by a low elevation (figs. 20, 21).

The parapodia (*p.*) are fully developed and situated at about two-fifths of the whole radius from the margin of the body; their muscles, especially the musculus centralis, are not strongly developed, as is also shown by the absence of radial elevations on the ventral surface of the body corresponding to them. The hook (fig. 24, *u.*) ends in a fine short point, bent so little that it only forms an obtuse angle with the axis of the stem (·013 mm. large). The manubrium (*ma.*) has a large stalk, which is of equal size throughout its whole length. At the extremity it is obtuse, and ends in two irregular swellings directed backwards. The hemispherical suckers (fig. 20, *s.*) are small, but project somewhat.

The mouth (*m.*) is placed very far back, nearly on a level with the insertion of the parapodia; the pharyngeal tube (*ph.*) projects from it; nearer to the margin than the mouth is the cloacal papilla (*cl.*), at the posterior end of the body.

The male genital papillæ (♂) are high cones with broad bases. They are considerably larger than the parapodia, close to which they lie.

The smaller individual is remarkably different from the one just described. It is oblong in shape instead of circular (fig. 23), and less convex on the dorsal surface; the portion of the body outside of the five pairs of elevations is gradually bent downwards. The median area lies in the same plane with these elevations, which are flattened and enlarged to five-sided masses, looking just as if the animal had been subjected to considerable pressure. The tubercles in the same way are flattened and polygonal, touching one another on all sides. The resemblance to tortoise-shell is almost more striking, since the median area is divided up by several transverse furrows.

In other respects the two individuals agree, and since they came from the same host, I do not doubt that they belong to one and the same species.

Host.—Actinometra lineata, P. H. C. Station 285 (Barbados) of the "Blake" Expedition.

13. *Myzostoma lütkeni*, n. sp. (Pl. II. figs. 20, 21).

This unique specimen from the Copenhagen Museum measures rather more than 3·5 mm. long and 3 mm. broad. The anterior margin is slightly notched, so that the contour is almost heart-shaped. The body is very compact and quite opaque. The dorsal surface is greyish-brownish-black in colour, and divided by deep and shallow furrows, with numerous irregular areas like the bark of a tree. The cirri are twenty in number, 0·6 mm. long, and arranged at equal distances from each other, except the first pair, which are separated by an interval double as great as that between the others. The ventral surface is very characteristic. All the usual elevations are distinctly seen. The parapodia and suckers are well developed; the latter project between the parapodia

as tubes with a crown of tubercles. All the elevations are marked out from the peripheral part of the ventral surface, which is blackish-brown, by their light yellow-brown colour. The peripheral portion is also bent upwards and radially furrowed in correspondence with the intestinal cæca. Through the mouth, at the anterior margin of the central elevation, projects the pharynx, which is provided with a subterminal crown of papillæ of ·18 mm. in length. The obtusely conical cloacal papilla at the hinder end of the ventral mass is further removed than the mouth from the margin of the body. The parapodia and suckers project equally at the commencement of the distal half of the radius.

Host.—Actinometra intricata, Lütken, sp., from Tonga, Copenhagen Museum.

14. *Myzostoma pallidum*, Graff.

Myzostoma pallidum, Graff, Genus Myzostoma, p. 18, pl. ii. figs. 6, 6*a*.

Hosts.—Actinometra solaris, Lam., sp., and *Actinometra parvicirra*, Müll., sp., from Bohol (Philippines).

15. *Myzostoma marginatum*, n. sp. (Pl. II. figs. 16–19).

The body is nearly circular in form and 2 mm. in extent; both dorsal and ventral surfaces are alike of a yellowish-brown colour. The former is somewhat vaulted, and appears irregular on account of several deep furrows and a number of tubercles arranged close together and of various sizes; these are only absent from a narrow transparent piece round the margin (fig. 16); the margin is provided with cirri ·18 mm. long. I was not quite certain about the number, but it seemed probable that they were limited to twenty. On the ventral side the margin of the body with its cirri is yet more conspicuous; the ventral muscular mass is of a considerable size (*cf.* ideal cross section, fig. 19).

The parapodia (fig. 18, *p.*) are of moderate size, and divided into an extremely fine terminal segment and a thicker basal part. Close to the third pair of parapodia are the conspicuous male genital papillæ (♂). The parapodia occupy a circle nearly mid-way between the centre and margin of the body; the circular suckers (*s.*) lie on the same level with the free ends of the parapodia. The oral and cloacal apertures are on the margin of the ventral muscular mass; the latter is a simple opening without papillæ. The small elevation behind the mouth shows that the pharynx is insignificant in size.

A small yellowish-brown individual, dredged at Martinique (Station 203) by the "Blake," is probably of the same species. This specimen is 1·2 mm. long, and has all the characters of the species, but less sharply marked. There are ten pairs of cirri, arranged in regular order, the largest of which measured ·1 mm. The terminal segments of the parapodia are sharply marked off from the basal as little button-like portions.

Host.—Actinometra discoidea, P. H. C., from Station 155 (Montserrat) of "Blake" Expedition. In this case the parasite was attached to the host. I have also a specimen

from Station 203 (Martinique), where *Actinometra discoidea* also occurred; but as the parasite was unattached, it may have belonged to one of the other *Comatulæ* occurring at this Station (*Actinometra meridionalis?*).

16. *Myzostoma brevipes*, n. sp. (Pl. III. figs. 19, 20).

In size and stoutness of build this species is intermediate between *Myzostoma glabrum* and *Myzostoma cirriferum;* it has, like the latter, a transparent marginal border, from which arise twenty short cirri, ·16 mm. long. The back is a bright gamboge-colour, and covered by deep folds; the larger of these were no doubt caused by the alcohol, but the finer peripheral folds correspond to the branches of the intestine. The flat ventral surface is a dull greyish-brown; the parapodia take their origin from small cavities on the ventral surface (see ideal section, fig. 20). They are, however, feeble and short (·18 mm. long), and reach but a little way beyond the margin of the cavities. Beyond the latter are traces of flat suckers. The diameter of the disc in the largest specimen is 2·3 mm.

Host.—Antedon pourtalesii, P. H. C., from Station 241 (off Carriacou) of the "Blake" Expedition.

17. *Myzostoma carpenteri*, Graff (Pl. II. figs. 10–15).

Myzostoma carpenteri, Graff, Proc. Roy. Soc. Edin., vol. xii. p. 380, 1884.

The adult individuals of this species, which I name in honour of my friend Dr P. Herbert Carpenter, are of a light yellow colour with fine wrinkles. The body is robust, and is everywhere of considerable thickness, as shown by the ideal section (fig. 14). The anterior margin is somewhat indented, the hind margin obtusely pointed; the diameter is somewhat greater than the length, and measures 2·3 mm; the shape of this species is therefore quite characteristic. On the margin are twenty cirri, the last pair of which are more distant from each other than the others. The bases of the cirri are broad, with a number of annular folds; the whole margin of the body is feebly excavated at intervals. The length and breadth of the cirri in the two individuals that I examined was quite different. In the one (fig. 13) they reach ·09 mm., in the other ·16 mm.

The parapodia are situated near the margin of the body (fig, 11), but are feebly developed; the short basal portion lies in a flat cavity, and the thin terminal part alone, which measures ·2 mm. and is often curved, is visible beyond it. The suckers are still nearer to the margin, and just as little developed. On the dorsal surface is a sharp keel, and on the ventral side, corresponding to it, is a more obtuse and less prominent keel (fig. 14). There is no trace of the central ventrally placed elevation, and as the pharynx also is marked on the outside by no elevation, it may be safely concluded that it is of small dimensions. I discovered the mouth after a laborious search; it is a fine slit on the bottom of the anterior notch of the body, and looks forwards and downwards; its margin is not at all thickened. The cloacal aperture is still more minute, and lies at the hindermost extreme of the body.

On the dorsal surface of the adult individual there was attached a young specimen (fig. 15), ·46 mm. long and ·5 mm. broad, delicate and transparent, with the marginal border extended into twenty long processes, the largest of which measured ·06 mm. The position of the mouth and cloaca (*m.*, *cl.*), and the feeble indication of the suckers (*s.*), seem to show that it is a young specimen of *Myzostoma carpenteri*, though I am fully aware that the young of *Myzostoma cirriferum* are characterised by a similar position of the mouth and cloaca. But in individuals of the size of the one displayed in fig. 15, the primary terminal position of these apertures is lost (see Genus Myzostoma p. 66), so that in this case it is lawful to draw a conclusion about the species to which this individual belongs. The relatively large size of the parapodia and pharynx of this young specimen is not of great importance, since in *Myzostoma cirriferum* and *Myzostoma glabrum* these organs do not grow so fast as the disk.

Host.—*Antedon dentata*, Say (=*Antedon sarsii*, D. and K.), from Station 5 (August 10, 1882) of the "Triton" Expedition, in 285 to 433 fathoms.

18. *Myzostoma areolatum*, n. sp. (Pl. III. figs. 1–3).

The largest of the five individuals that I examined measures 1·5 mm. in length and ·9 mm. broad. The body is of an opaque brown, like leather, and flat above and below; the margin is thinner than the median part, which is rather prominent on the ventral aspect (see ideal section, fig. 3). The dorsal surface is divided by a number of furrows into polygonal areas (fig. 1) of four sides, which are largest in the middle, and owing to the longitudinal course of the larger furrows are grouped lengthways. Towards the margin the furrows become shallower and more irregular, and the areas smaller, till close to the margin the surface is covered by small wrinkles, which cause the edge to be slightly notched. The cirri are represented by twenty unequal tubercles (fig. 2, *c.*), which almost disappear in some individuals. As in *Myzostoma glabrum*, the sexual organs and intestinal cæca do not extend beyond the ventral elevation, at the anterior extremity of which is the mouth (*m.*), and at the posterior the cloacal opening (*cl.*). The bulbus musculosus of the pharynx (*ph.*) has a length of nearly one-third of that of the body. The parapodia (*p.*) are short and strong, ending obtusely. The oval suckers (*s.*) lie in the ventral elevation, removed from the margin by a distance equal to their own length.

Hosts.—(*a*) *Actinometra blakei*, P. H. C., from Station 172 (Guadeloupe) of the "Blake" Expedition.

(*b*) *Actinometra meridionalis*, var *quadrata*, P. H. C., from Station 203 (Martinique) and Station 278 (Barbados) of the "Blake" Expedition.

19. *Myzostoma triste*, Graff.

Myzostoma triste, Graff, Genus Myzostoma, p. 19, pl. ii. fig. 5.

Of this species, already described by me, I received three specimens from the Copen-

hagen Museum. They were all of equal size, about 3·5 mm. long, and differed from the Bohol specimen in their yellowish-brown colour, opaqueness, and larger size. One specimen had the dorsal surface finely granulated; and a renewed examination of the specimen from Bohol, formerly described by me, showed granulations here and there.

Hosts.—(*a*) *Actinometra parvicirra*, Müll., sp., from Bohol (Philippines). (*b*) Uncertain. The Copenhagen specimens were taken from Crinoids (*Actinometra, Antedon*) from the central part of the Southern Sea (Tahiti, Samoa, &c.), but no more exact statements can be made. Two other smaller individuals (2·27 mm. long) I got from an undetermined species of *Comatula* from the British Museum. The locality, however, was unknown.

20. *Myzostoma coriaceum*, n. sp. (Pl. XI. figs. 1–3).

By the permission of Dr. A. Günther, I received from Prof. Jeffrey Bell three specimens of a *Myzostoma* found by Mr. P. H. Carpenter on an *Antedon* (*Antedon insignis*, Bell, MS.) dredged during the "Alert" Expedition; this is the largest species known to me. The diameter of the circular body is about 9 mm., and as the margins are bent down, the animal must really measure as much as 1 cm. when fully extended. The colour is a darkish brown, only a marginal zone about ·3 mm. wide being of a somewhat lighter colour, but not in the least transparent. The dorsal surface has irregular folds, caused no doubt by the alcohol; the skin is smooth and without tubercles. The consistency of the body is very much that of leather, but the thickness is inconsiderable,—this species is in fact almost the thinnest known, as may be seen from the ideal cross section (fig. 3). The margin of the body has twenty cirri, measuring from ·23–·3 mm. in length, and it is a curious fact that the smallest specimen, 2·7 mm. in diameter, has cirri proportionally far larger; they measure about ·22 mm. long. The parapodia (*p.*) are near the centre of the ventral surface at about the end of the inner third of the radius. From the external margin of their insertion to the tip they measure about ·7 mm., and are in consequence relatively small. Slightly outside of the parapodia, about half-way between the margin and the centre of the body, are the prominent rounded suckers (*s.*), ·3 mm. in diameter; they are conspicuous by the fine folds on their free surface. At the same level as the suckers are the oral (*m.*), cloacal (*cl.*), and two male genital (♂) apertures; the latter are situated at the extremities of papillæ considerably larger than the parapodia.

Host.—*Antedon insignis*, Bell, MS., from Station 110 (Port Denison, 3 to 4 fathoms) of the "Alert" Expedition, British Museum.

21. *Myzostoma radiatum*, n. sp. (Pl. III. figs. 12, *A*, *B*).

The form of this species is very peculiar; the back is flat, while the ventral surface is vaulted (see ideal cross section, fig. 12, *B*). Seen from below (*A*) this massive swelling is intersected by ten radial furrows, dividing up its area into as many sectors, each of which

becomes larger towards the margin, and bulges slightly forward. In the middle of the outer extremity of each of these is a small conical tubercle—the parapodium—which is at the most ·1 mm. long. The third sector is slit on both sides by a secondary furrow, in which lies the parapodium as well as the male genital aperture; there are two fine tubercles also occupying the tip of the secondary prongs. The flat suckers are at the external margin of the ventral elevation, in the chief furrows and closer to the dorsal portion. Just beneath the marginal zone of the dorsal disk are the mouth and cloacal apertures. The long pharynx is much extended forwards and flexed towards the dorsal aspect. The ventral surface is rather lighter in colour than the back, and not so smooth, but divided by shallow furrows into a number of polygonal areas about ·07 mm. in breadth.

Host.—The single specimen was found on an *Actinometra*, closely allied to, if not identical with *Actinometra meridionalis*, A. Ag., dredged by Capt. Werner in 1873, near Barbados; it belongs to the Kiel Museum.

22. *Myzostoma pulvinar*, Graff (Pl. III. figs. 21–23).

Myzostoma pulvinar, Graff, Proc. Roy. Soc, Edin., vol. xii. p. 379, 1884.

This species, of which I possess only one specimen, is very much like *Myzostoma radiatum*; the dorsal surface in both species is flat and the ventral surface vaulted. The oral and cloacal apertures, however, differ in being on the dorsal surface. This latter is formed by a transversely oblong plate, marked off sharply from the rest of the body; the margin of which is bent upwards in front and at both sides, but downwards behind (fig. 21). The diameter of this dorsal disk, which is quite smooth, save for the reflected portions that are slightly wrinkled, is 3·2 mm., the length 2·7 mm. The obtusely pointed cloacal papilla is ·45 mm. distant from the hinder end of the body; the mouth has a thick lip, and is not so far from the anterior end of the body as the cloacal papilla. The massive pharynx protrudes from the mouth. The body is of a firm consistency; the colour is a uniform yellowish-brown.

This species is thicker in proportion than any other; there is only a narrow marginal zone not occupied by the hugely developed ventral elevation. The anterior and posterior borders of this elevation are parallel, the distance between them being 2·3 mm.; the sides are rounded, the transverse diameter being 3·4 mm. The ventral elevation is distinctly marked off from the dorsal disk by its considerable cross extension, and it is very prominent when observed from above.

The parapodia arise from the margin of the ventral elevation; the anterior pair being situated at the junction between the straight anterior and the rounded lateral margin. The parapodia are at equal distances from each other, and it is only the last pair which are separated by a somewhat wider interval. The parapodia appear as if they were almost immovable; the hook apparatus is strongly developed and projects greatly; in the specimen that I examined it projected ·2 mm., and even the point of the manubrium came

out beyond the parapodium. Fig. 23 represents the portion of the hook-apparatus which extends beyond the parapodium. This part of the hook is ·2 mm. long and ·02 mm. broad; the end is bent at more than a right angle and gracefully curved. There is no separate manubrial plate—the end of the manubrium merely becomes thinner, more flattened, and bent backwards, so that it embraces nearly the whole hook (*ma.*). The whole manubrium is covered by numerous tubercles, which show the powerful development of its muscular system. These chitinous parts are of a deep dark yellow and yellowish-brown where the light falls upon them. I have not succeeded in finding any trace of suckers.

Host.—The single specimen was found upon the peristome of *Antedon phalangium*, Müll., sp., dredged in the Mineh, from 60 to 80 fathoms, August 14, 1869, by H.M.S. "Porcupine."

23. *Myzostoma calycotyle*, n. sp. (Pl. III. figs. 24–26).

The colour of the animal varies from dirty grey to brownish; the shape of the body is oblong, the diameter being 3·6 mm., and the length 2 mm. The convex dorsal surface is covered with small scattered whitish papillæ, while the concave under surface is much bent and folded. The margin is beset with numerous cirri of ·2 mm. in length, and considerably bent upwards (fig. 24). The shape of the specimen renders an examination of the ventral side very difficult. A portion of the parapodia and suckers are squeezed into the furrows, so that it is quite impossible to examine them properly, which is much to be regretted, since the type is an interesting one. In the first place, the suckers are not situated, as is usual, between the parapodia, but arise quite near their base (fig. 26). The suckers (*s.*) are distinguished by being very strongly developed; their shape is also peculiar; they closely resemble stalked goblets, and their greatest diameter is ·34 mm. The relation of the two anterior pairs of suckers to the parapodia may be seen in the specimen; they lie, with respect to the short axis of the body (fig. 25), outside the parapodia (*a.* and *b.*), but joined to them. It may therefore be safely concluded that the shorter diameter represents the longitudinal axis. The only opening that can represent the mouth falls within this line, between the two suckers and parapodia (fig. 25, *a.* and *b.*). This mouth opening is then rather dorsal in position (fig. 24, *m.*). I did not discover the cloacal opening.

Host. — *Pentacrinus alternicirrus*, P. H. C., from Station 214 (south of Philippine Islands) of the Challenger Expedition.

24. *Myzostoma compressum*, n. sp. (Pl. III. figs. 4–8).

This species is distinguished by its yellowish-brown colour and laterally compressed shape (see ideal section, fig. 7); the back runs up like a keel, which is considerably higher than the animal is broad. The skin of the back is quite smooth; the margin of the body, as I observed in a specimen preserved by v. Willemoes Suhm, is provided with twenty cirri, resembling very closely in size those of *Myzostoma coronatum*; the largest are ·2 mm. long.

The parapodia (fig. 5) are relatively feeble, and approximated to the flat margin of the ventral surface; the strong flexure of the hooks (*u.*) and the manubrial plate (*ma.*) is shown in fig. 4; the suckers, which I only saw in v. Willemoes Suhm's preparation, are small, oval, and flat. The length of the ventral disk is 2·3 mm., the breadth 1·2 mm.; the mouth is subterminal, and the pharynx provided with a very long bulbus musculosus; the cloacal opening is terminal.

Host.—Bathycrinus aldrichianus, Wyv. Thoms., from Station 146 (Prince Edward Island, Crozets) of the Challenger Expedition.

25. *Myzostoma brevicirrum*, n. sp. (Pl. VI. figs 3, 4).

The largest of the six specimens which I had at my disposal was ·5 mm. in diameter, and had the form of a transparent circular yellowish plate. The eggs were fully developed; the spermatic vesicles and vasa deferentia were quite full of spermatozoa, showing that the individual was an adult.

One of the specimens is brown, but this colour is probably due to the pigments of its host dissolved in the alcohol. The marginal border measures ·015 mm. across, and is provided with short wart-like cirri, measuring about ·01 mm. and situated at even distances. The alimentary canal is not remarkable; the pharynx has a large bulbus musculosus, and is provided with papillæ. The oral and cloacal apertures lie between the centre and margin of the body. The round suckers, ·01 mm. in size, lie at the commencement of the exterior third of the radius. The strongly developed parapodia lie between the middle and border of the body. The hook-apparatus is feeble; the hook is ·09 mm. long (fig. 4, *u.*) and the manubrium (*ma.*) ·07 mm. long, provided with a single end plate.

Since in individuals of ·24 mm. diameter the vasa deferentia and the seminal vesicles are filled with spermatozoa, whereas the eggs are but little developed, it may be concluded that the male apparatus is earlier developed than the female.

Host.—Actinometra mutabilis, Lütken, MS., from the Copenhagen Museum (No. I. from 23° 20′ N., 118° 38′ E.; 17 fathoms; No. III. from Tonga.).

26. *Myzostoma pictum*, n. sp. (Pl. II. fig. 22).

The fine markings on the back of this species are sufficient to recognise it by, though the rolled-up condition of the single specimen did not allow of any exact examination into the conditions of the ventral side. I am only able to state that the parapodia are but feebly developed, and are merely small stumps of ·1 mm. in length, situated in slight depressions of the integument, and hardly recognisable even by the help of a lens.

In the middle part the body is nearly as stout as in *Myzostoma cirriferum*, but becomes gradually thinner towards the marginal border, which is therefore not distinctly separated from the central part, although it contains none of the intestinal branches; it is indeed semitransparent, but of the same consistency as other parts of the body. On the dorsal surface are three prominent pale yellow coloured longitudinal bands; the median one is

the largest, and from it are seen to radiate outwards a number of yellow coloured marks which correspond to the intestinal cæca. The intervals between the longitudinal bands are brownish coloured, and the intervals between the lateral ramifications are greyish-brown, becoming darker towards the ends of the lateral branches. The margin of the dorsal disk is bordered by a yellowish band. The transverse diameter of the body is 1·8 mm.

Host.—Probably *Antedon spinifera*, P. H. C. From Station 157 (Montserrat) of the "Blake" Expedition.

27. *Myzostoma nigrescens*, n. sp. (Pl. III. figs. 13–15).

In size, number, and arrangement of cirri, and in general appearance, this species much resembles *Myzostoma cirriferum*, differing only by its smaller length (2·5) and by not having a translucent marginal border. The body of the single individual that I was able to examine is coloured blackish-brown above, and below a little lighter coloured; it is thick not only in the middle of the body, but also at the margin; it is therefore hardly at all translucent. The parts of the hook-apparatus (fig. 14) are also much more strongly developed; the hook (*u.*) is provided with a straight extremity set at right angles to the rest of the shaft; it is ·17 mm. long and ·016 mm. thick. The manubrium (*ma.*) is short, measuring only ·12 mm. long; the terminal plate is distinguished by its smooth surface and bent edge.

Of the twenty cirri the anterior pair are the largest, and measure ·45 mm.; the rest are much shorter (·27–·35 mm.). The third cirrus on the left side shows an abnormality already noticed by me in *Myzostoma cirriferum* (Genus Myzostoma, p. 79); it is forked at the extremity, one of the ends being short and stump-like, the other long.

Host.—*Actinometra morsei*, P. H. C. Found by E. S. Morse in Yeddo Bay (Japan); the property of the Museum of Comparative Zoology, Cambridge, Mass.

28. *Myzostoma cirriferum*, F. S. Leuckart.

Hosts.—(*a*) *Antedon rosacea.*—Mr. P. H. Carpenter has specimens from Shetland (Bressay Sound, 5 to 7 fathoms), and Arran (5 to 10 fathoms), which confirm the assertion that this parasite occurs in all European seas where its host occurs (see Genus Myzostoma, p. 79).

(*b*) *Antedon petasus*, P. H. C.—Mr. Carpenter has specimens from Norway, the Kiel Museum from Arendal, Norway; and H.M.S. "Triton" dredged some at Station 3 (August 8, 1882, 81 fathoms).

(*c*) *Antedon hystrix*, P. H. C., from North Atlantic (probably cold area), "Porcupine," 1869.

29. *Myzostoma crenatum*, n. sp. (Pl. VII. fig. 4).

This species is one of the most elegant and regular among the flat Myzostomida. The

body is perfectly circular, thin, brownish-yellow coloured with a broad transparent marginal zone. The largest of the three specimens is 1 mm. in diameter, the smallest ·6 mm. There are twenty thick obtusely pointed cirri of equal length (in the larger specimen ·9 mm., in the smaller ·056). Their bases are continued for some way into the interior of the disk. In the intervals between the cirri, the margin of the body is prolonged into rounded lobes. The parapodia (*p.*) are comparatively well-developed, and are arranged in a circle at about the inner third of the radius; outside are the large oval suckers (*s.*), distant from the margin about their own length. The mouth (*m.*) and cloacal aperture (*cl.*) lie at the same level as the suckers. The pharynx (*ph.*) is well-developed; the male genital papillæ (♂) form two tubes of the same length as the parapodia, and reaching to the margin of the body.

Host.—This species was found in bottles containing Crinoids collected at Station 203 (Martinique) of the "Blake" Expedition, and in bottles containing Crinoids dredged by the American telegraph steamer "Investigator," under the command of Captain Cole, near St. Lucia, in lat. 13° 22′ N., long. 61° 7′ W.; 278 fathoms. (Both belong to the Museum of Comparative Zoology, Cambridge, Mass.) From P. H. Carpenter's list of the Crinoids dredged at these two Stations it appears that *Actinometra meridionalis*, A. Ag., is the only species that occurs at both Stations, hence it is probably the host of *Myzostoma crenatum*.

30. *Myzostoma wyville-thomsoni*, n. sp. (Pl. VI. figs. 1, 2).

Both the specimens that I had in my possession were much damaged, and fig. 1 is therefore "restored." This species is thin and fragile, and of a dirty-white colour. In the middle it has the thickness of a small *Myzostoma cirriferum;* the portion lying outside the suckers, which are placed very far inwards, is delicate and transparent; there is, however, no precise line of division between the two. There are twenty strongly developed cirri, the first and second pairs of which are situated at a greater distance from each other than the rest, and are remarkable for their large size (as much as ·6 mm. long); the base is continued into the ventral surface. The body is oval, and 2·3 mm. long by 1·7 mm. broad. The parapodia (*p.*) are somewhat remarkable; they are ·7 mm. in length, and the large basal part, which includes the manubrium and its muscles, is sharply marked off from the narrow terminal portion, which is often bent or rolled. It is very clear that the slender hook emerges from the distal end of the basal portion and not from the terminal portion, since the latter is furrowed and not tube-like; the hook lies in this furrow, but emerges from it when it commences to be twisted. The largest hooks measure ·015 mm. thick and ·56 mm. long; they are clear and transparent. The tip is rather bent and somewhat swollen at the anterior end before the bending (fig. 2); this is the thickest portion of the whole hook. The mouth (*m.*) lies a little outside the circle of the suckers; the pharynx (*ph.*) is nearly one-third of the entire length of the body. The branches of the intestine and the genital apparatus I did not see.

Host.—(*a*) *Metacrinus costatus*, P. H. C., n. gen. and sp., from Station 214 (south of Philippine Islands) of the Challenger Expedition (500 fathoms).

(*b*) Another specimen was found by Mr. Carpenter attached to the anal tube of *Metacrinus angulatus*, P. H. C., n. gen. and sp., from Station 192 (south-west of Papua) of the Challenger Expedition. It was 3 mm. in length, and the bulbus musculosus of the pharynx measured ·9 mm. in length.

31. *Myzostoma vastum*, n. sp. (Pl. VII. figs. 2, 3).

The four specimens which I examined came from *Actinometra japonica*, and belong to the Leyden Museum. They are characterised by the smallness of the marginal border, due to the extension of the intestinal cæca (*i.*) and the ovarian follicles (*ov.*) nearly as far as the margin, and by the larger size of the twenty cirri. The first, second, ninth, and tenth pairs of cirri are the longest, especially the ninth, which in the specimen displayed in fig. 2, measure ·6 mm. in length and ·068 mm. in diameter at the base. The third and the eighth pairs are the shortest, and measure no more than ·2 mm. The large oval flat suckers (*s.*) stand at the same level as the ends of the parapodia; the parapodia are strongly developed. The cloacal aperture (*cl.*) lies at the same height as the external margin of the suckers, but the oral aperture is beneath the anterior margin when the pharynx is contracted. In the specimen figured, however, the pharynx is extended, showing its crown of papillæ, and so the appearance is different, since the mouth opening is so much enlarged that its posterior margin is withdrawn further inwards into the disk of the body.

The colour of the animal is lightish brown, inclining to yellow towards the margin; the body is about as thick as in *Myzostoma cirriferum*. The largest specimen measured 1·7 mm. long by 1·47 mm. broad. In one individual the dimensions of the cirri were somewhat different from the description given; the last pair appeared to be extremely shortened, shorter than the lateral cirri, and one had an abnormal lateral branch (fig. 3).

Two smaller specimens, dredged during the "Blake" Expedition, appeared from their general configuration to belong to this species. The ten pairs of cirri were of equal length, and arranged at equal distances from each other; one specimen (host uncertain) was ·7 mm. in length, with cirri of ·056 mm. in length; the other (from *Actinometra meridionalis*) was ·97 mm. in length, and the cirri ·136 mm. The last specimen had its pharynx fully extended and crowned with a circlet of papillæ.

Host.—(*a*) *Actinometra japonica*, Müll., sp., from the Leyden Museum.

(*b*) *Actinometra blakei*, P. H. C., from Station 39 of the "Blake" Expedition. The same species of *Myzostoma* was also found in the bottle containing the Crinoids collected at Station 203 of the "Blake" Expedition. The fact that *Actinometra blakei* occurred in this bottle, probably shows that it is to be considered as the host of this *Myzostoma*.

32. *Myzostoma agassizii*, n. sp. (Pl. VII. fig. 1).

The body is circular and extremely delicate, and transparent not only in the marginal border, but in the part which lies outside the parapodia and suckers, and contains the intestinal cæca. The margin is provided with twenty cirri, which are very long and drawn out into fine points, and show very distinctly a glutinous cell furrow. The longest cirrus of the individual shown in fig. 1 measures ·57 mm., the diameter of its base being ·06 mm. The last two pairs are the largest, and the interval between them is greater than that between the rest. In another specimen one of the lateral cirri measured ·2 mm., the penultimate (and longest) ·45 mm.

I examined in all twenty-two specimens, which varied from ·3 mm. to 1·4 mm.; they were all light yellow to dark brown in colour; the cirri of the smallest specimens were of equal length, measuring about ·045 mm. and at an equal distance from each other; the tenth pair of cirri become much longer than the lateral cirri in individuals of ·6 mm. in length and upwards.

The small size of the body and the fineness of the cirri give this species a peculiarly elegant appearance; it no doubt moves in great part by undulations of the body, inasmuch as none of the specimens that I examined save the two smallest were without some bendings and foldings of the margin of the body. The parapodia (*p.*) are feeble, and situated nearer to the centre than to the margin; the small oblong, indistinctly-marked suckers (*s.*) are situated far inwards, in the region of the intestinal cæca. The mouth is ventral, and lies on a level with the terminations of the intestinal cæca, while the cloacal aperture is distant from the margin about twice as far as the mouth. The pharynx has a long bulbus musculosus (*ph.*).

Hosts.—This species has at least two hosts, but only one can be mentioned with certainty.

(*a*) *Antedon hageni*, Pourt., dredged by "Bibb" Expedition near Bahia Honda, in 100 fathoms, on May 4, 1868. *Antedon hageni* was also most probably the host at Station 32 (August 1877) of the "Blake" Expedition.

(*b*) *Myzostoma agassizii* was also taken at Stations 155 and 269 of the "Blake" Expedition. *Antedon hageni*, however, occurred at neither of these Stations; the species found in great number at both was *Antedon spinifera*, P. H. C., which, therefore, is probably the host.

33. *Myzostoma dubium*, Graff.

Myzostoma dubium, Graff, Genus Myzostoma, p. 14, pl. ix. figs. 2–5.

Hosts—*Antedon triquetra*, Semper, MS., and *Antedon dubia*, Semper, MS., Bohol (Philippines).

34. *Myzostoma mœbianum*, n. sp. (Pl. VIII. figs. 3–10).

Prof. K. Mœbius sent to me in 1877, together with some sketches and notes, preparations of a *Myzostoma* found by him near Mauritius. Since the preparations were, with the exception of the hook-apparatus, not well preserved, I shall follow in my description Dr. Mœbius' notes.

Length about 1·4 mm., breadth 1 mm., somewhat greater in front than behind, so that the contour is oval. The body is vaulted above and slightly concave below; it is of moderate thickness. The cirri are bluntly terminated, and attain a length of ·09 mm.; they are arranged fourteen on each side with an odd one at either end of the body. The skin (fig. 8) is ciliated. The parapodia (*p.*) are strong and contain a bent hook (fig. 10) of ·17 mm. in length and ·017 mm. in breadth; the manubrium is ·13 mm. long, and the hatchet-shaped end plate (*ma.*) is divided on the margin into five prongs; there are also additional hooks still contained "in their formative sheaths." Of the five pairs of "suckers" figured by Dr. Mœbius, one pair seems to me to be really the male generative apertures (♂). The pharynx is represented in fig. 3 in a contracted state, stretched out in fig. 4; the small ramified intestinal cæca (*i.*) are given off from two main trunks. The mouth (*m.*) and cloacal aperture (*cl.*) lie upon the ventral side, but the latter is about twice as far from the margin as the former. All three specimens were sexually mature, and in fig. 3 are shown the testicular follicles (*t.*) occupying all the body except a small border, as well as some of the numerous ripe eggs (*ov.*).

"The stomach and the intestinal branches are lined with reddish cells, carrying cilia and containing yellow fat globules coloured black by osmic acid. The rectum (fig. 5 represents its epithelium) is divided from the stomach by a circular muscle. The cirri bear fixed hairs (fig. 7). The animal cannot easily be removed, without injury, from the *Comatula*. It is supported by its cirri, which it winds round the pinnules of its host. The colour is reddish and transparent."

Host.—*Comatula*, sp., dredged in 18 fathoms on November 5, 1874, at Fouquet Island, south-east from Mauritius.

35. *Myzostoma elongatum*, Graff.

Myzostoma elongatum, Graff, Genus Myzostoma, p. 13, pl. xi. figs. 1, 2.

Host.—*Antedon triquetra*, Semper, MS., Bohol (Philippines).

36. *Myzostoma verrucosum*, Graff.

Myzostoma verrucosum. Graff, Genus Myzostoma, p. 17, pl. ii. fig. 1.

Host.—*Antedon triquetra*, Semper, MS., Bohol (Philippines).

37. *Myzostoma dentatum*, n. sp. (Pl. IX. fig. 1).

Of this elegant species I have but a single example, which is, fortunately, well preserved. The body is regularly elliptical, 1·9 mm. in length, and 1·25 mm. in diameter. It is thin and delicate, and has a membranous appearance. The central part alone crowned by the bases of the parapodia, is somewhat thicker and of a brownish colour. The outer extremities of the ramified intestinal cæca (*i.*) are distinctly visible, and sharply marked off from this part of the body is the brownish-yellow border, which is ·19 mm. in diameter. Instead of cirri there are a number of obtuse teeth-like serrations upon the border, which measure at most ·136 mm. long; they are irregular in size and number. There are twenty to thirty larger ones, and between them a number of smaller projections, one of which lies in the middle line just at the anterior end of the body, and another in the middle line at the posterior end.

The small rounded suckers (*s.*) lie in the middle of the lateral margins of the body and occupy about one-third of them. The strong parapodia (*p.*) lie entirely within the central part of the body, which is occupied by the intestinal cæca; the broad obtuse terminations are prominent only in some of them. On the margin of the central part above the third parapodium is visible on either side the large vesicula seminalis (*vs.*); on the hinder margin of the central part is the cloaca (*cl.*). The mouth (*m.*) lies quite on the border of the body. The bulbus musculosus (*ph.*) of the pharynx is of extraordinary size—one-third of the length of the body.

Host.—Antedon bidentata, P. H. C., from Station 186 (Torres Strait) of the Challenger Expedition.

38. *Myzostoma fimbriatum*, n. sp. (Pl. VI. figs. 5, 6).

I had only one specimen, which measured about 1·8 mm. in length and 1·5 mm. in breadth. Though much damaged it appeared to resemble *Myzostoma cirriferum* in form, colour, size, and arrangement of parapodia and suckers. The suckers, however, are round, and there is a distinct male genital papilla on either side between the third parapodium and the margin of the body, which is about half the size of one of the parapodia. The border of the body is not transparent, and is not so sharply marked off as in *Myzostoma cirriferum;* the twenty cirri are relatively shorter, the largest measuring only ·08 mm. The most striking feature is the tufts of fine hairs, ·02 mm. long, on the margin of the body (5, *a*). They were only well preserved on one part of the specimen; highly magnified (fig. 6) they have the appearance of glass, and are clubbed or bent at the extremity. The insertion of their base into the tissue of the body proves that they are not mere cuticular formations.

Host.—Antedon eschrichti, Müll., sp., or *Antedon quadrata*, P. H. C., from Station 48 (South of Halifax) of the Challenger Expedition.

39. *Myzostoma excisum*, n. sp. (Pl. VIII. fig. 2).

This species is characterised by the deep excision of the hinder margin of the body, caused by the prolongation of the lateral parts beyond the cloacal papilla (*cl.*). The body is flat, strong, dark brown in colour, and slightly transparent only upon the marginal parts. The latter are prolonged into ten pairs of obtusely-pointed cirri, of which the last pair occupy the two ends bordering the notch. The hinder half of the body being the largest, the whole animal has a heart-shaped contour. That portion of the ventral surface which is enclosed by the suckers on either side, by the mouth in front, and by the cloacal papilla behind, is rather swollen and marked off from the marginal part. The parapodia (*p.*) are very large and well developed; they are nearly as long as the radius of the body, and project beyond its margin. The large pharynx is protruded considerably beyond the mouth. The length of the specimen, from the anterior end to the cloaca, is ·8 mm., the length of the lateral portions 1 mm. the greatest breadth ·9 mm., the length of the largest cirri ·12 mm. Besides this specimen, which was dredged during the "Blake" Expedition, I examined a smaller one from the Kiel Museum, which measured only ·54 mm. long.

Hosts.—(*a*) *Antedon hageni*, Pourt., dredged by the U. S. S. "Bibb" on the Alligator Reef, in 96 fathoms, May 6, 1868.

(*b*) *Antedon impinnata*, P. H. C., from Mauritius, North Bay, 15 fathoms, belonging to the Kiel Museum.

40. *Myzostoma irregulare*, n. sp. (Pl. IX. figs. 2–5).

I include under this species, so named on account of the irregularity in the formation of the cirri, several forms, the strict affinities of which must be cleared up by future investigation. I shall at present describe every variety.

(A) Fig. 2 represents, without doubt, the type of the species; it was taken at Station 249 (Grenada) of the "Blake" Expedition. There are four individuals, all of which are delicate and yellowish in colour, with a transparent border; there are ten pairs of longer cirri and a number of smaller wart-like secondary cirri arranged singly or in pairs between the others; a single median cirrus (*c.*) is situated at the hind end, and is very characteristic. The specimen figured is ·8 mm. long, ·7 mm. in breadth, and the longest cirrus measures ·12 mm. Another specimen measured 1·2 mm. in length, and 1·1 mm. broad; the cirri were proportionately smaller, though actually larger than those of the last mentioned individual. In none of the specimens belonging to this group could any regularity in the arrangement of the smaller cirri be observed (see p. 8).

The strongly developed parapodia (*p.*) occupy the middle region between the margin and the centre of the body, and the large oval suckers (*s.*) lie between the parapodia and the margin of the body.

The mouth (*m.*) and the cloaca (*cl.*) lie on a level with the ends of the parapodia; the pharynx is well-developed, the intestinal cæca are much ramified. The male genital apertures are upon the summit of a broad obtuse elevation (δ).

(B) The form represented in fig. 3 was taken in the Caribbean Sea ("Blake" Expedition), and differs from A, especially by its dark brownish tint; the male genital papilla is extended into a tube, which is to be explained by the contractility of the structure, and does not therefore imply a specific distinction; the same thing may be said concerning the differences in the length and thickness of the principal cirri and the arrangement of the secondary ones.

(C) A third form (fig. 4) differs only from B by the smaller size of its body, and from A and B by the circular form of the suckers (*s.*), the regular intercalation of the secondary cirri, and the presence of two odd median cirri, one at either extremity of the body (*C* and C_1). Nevertheless, bearing in mind what was said in the Introduction concerning the limitation of species, A, B, and C would appear to be identical.

(D) Two specimens from Tortugas ("Bibb" Expedition), whose identity with the described forms A, B, and C must be considered as doubtful. One of them, represented in fig. 5, is ·4 mm. long, and has twenty obtusely pointed cirri, arranged at equal distances from each other and of the same length (·07–·09 mm.); the odd median cirri are wanting.

(E) Two individuals from Stations 45 and 249 of the "Blake" Expedition, as large as B, belong probably to this species, but they are too much damaged to decide the question.

(F) Finally, there is a small specimen, found by Mr. P. H. Carpenter on a specimen of *Actinometra meridionalis*, A. Ag., sp., in the Copenhagen Museum. This specimen had a feebly developed cirrus behind, and is possibly an intermediate form between A and D. Also the body, which is ·5 mm. long, is provided with abnormally large cirri. On the left side the first to the fifth, on the right the first to the eighth of the cirri are of equal length, about ·09 mm., while the others are shorter, especially six to nine of them on the left side, which measure from ·0087 mm. to ·02 mm. The tenth cirrus of the left and the ninth and tenth on the right are again a trifle larger, measuring about ·03 mm.

Hosts.—The only forms which can possibly be regarded as the hosts of this species are *Actinometra meridionalis*, A. Ag., sp., and *Actinometra meridionalis*, var. *carinata*, P. H. C.

This may be stated with certainty for the forms

(D) "Bibb," January 16, 1869, west of Tortugas.

(E) "Blake," No. 45, 1877–78.

(F) Copenhagen Museum (U. S. Coast Survey, 100 fathoms).

In all these three cases *Actinometra meridionalis*, A. Ag., sp., was the host.

(E) This form was found upon both the mentioned forms of *Actinometra*, from Station 249 (Grenada) of the "Blake" Expedition.

(A) Station 249 (Grenada) of the "Blake" Expedition, probably from *Actinometra meridionalis*, var. *carinata*, P. H. C.

(C) Station 203 (Martinique) of the "Blake" Expedition, probably from *Actinometra meridionalis*, var. *carinata*, P. H. C.

(B) "Blake" Expedition, Caribbean Sea, 1877–78 or 1878–79 (label lost). Nothing can be stated with certainty respecting the host of this form, though it is probably *Actinometra meridionalis*, A. Ag., sp., which occurs at this Station.

The fact that the hosts of all these forms of *Myzostoma*, which I have united under the same specific name, are so very closely allied, seems to confirm the justice of my view.

41. *Myzostoma caribbeanum*, n. sp. (Pl. X. fig. 4).

The single specimen that I possess has an oval thin body, equally rounded at the fore and hind ends; its colour is a dirty yellowish-brown, the length is 1·2 mm. and the breadth 1 mm. It is somewhat thicker and less transparent in the middle than towards the edge. There are forty-three obtuse cirri, measuring up to ·09 mm. in length; they cannot be divided into principal and secondary cirri, inasmuch as there are all possible intermediate conditions, from minute tubercles up to the longest cirri. At the hinder extremity is an unpaired median cirrus (*C.*). The parapodia (*p.*) are feeble, and occupy nearly the middle third of the radius. The round suckers (*s.*), which are small but very distinct, are in the middle line between the bases of the parapodia and the margin of the body. On the same level with these are the mouth opening (*m.*), the cloaca (*cl.*), and the obtusely ending genital papillæ (♂).

Host.—Uncertain. "Blake" Expedition, Caribbean Sea, 1877–78 or 1878–79 (label lost).

42. *Myzostoma rotundum*, n. sp. (Pl. X. fig. 2).

The animal is nearly circular, and of a yellowish colour at the margin, inclining to brown in the middle of the body; its length is ·832 mm., diameter ·88 mm., it is therefore one of the smallest species of the genus. The marginal border is prolonged into a number of short obtuse cirri, the longest of which measure ·08 mm., while the smallest are minute tubercles. The single specimen has altogether fifty-one cirri, arranged in quite an irregular fashion; the large and small cirri are at unequal distances and bear no relation to each other in their arrangement. The pharynx (*ph.*) is large and conspicuous, as also the stomach, cloaca (*cl.*), and the ten intestinal cæca (*i.*), especially on one side. The parapodia (*p.*) are relatively feeble, and occupy a circle at the inner end of the middle third of the radius; the large round suckers (*s.*) lie at the boundary of the middle and the last third of the radius, as also the mouth and cloacal aperture (*cl.*).

Host.—Probably *Actinometra meridionalis*, var. *carinata*, P. H. C., from Station 249 (Grenada) of the "Blake" Expedition.

43. *Myzostoma oblongum*, n. sp. (Pl. X. fig. 3).

Of this elegant species I have but one specimen, which unfortunately is not well-preserved; but I have been able nevertheless to make out the characteristic features of the species. The body is delicate and oblong, 1·7 mm. long and 1 mm. broad; the two ends are obtusely rounded. The marginal border is broad (one-sixth of diameter), distinctly separated, and quite transparent; it is provided with forty-four cirri (there were at any rate twenty-two upon one side, the other was not sufficiently well-preserved to make out their number); the cirri are ·045–·18 mm. in length, they are large, of equal diameter along their whole length, and terminate in an obtuse point. The suckers (*s.*) lie within the marginal border; they are rendered distinct by their darker colour and large size; they are hemispherical in shape and ·14 mm. in breadth. The parapodia (*p.*) are feebly developed, and the pharynx (*ph.*) is small and retracted inwards. The mouth (*m.*) is ventral and situated in the middle of the marginal border; the cloacal aperture was invisible, owing to the hinder part of the body being filled with ripe eggs (*ov.*).

Host.—Probably *Actinometra meridionalis*, var. *carinata*, P. H. C, from Station 249 (Grenada) of the "Blake" Expedition.

44. *Myzostoma abundans*, n. sp. (Pl. X. fig. 1).

This specimen is 3 mm. in length, and its greatest diameter 3·2 mm.; it was dredged at Martinique. On examination with a lens and by transmitted light, the three regions into which the body is divided are very distinct; the middle portion is yellowish-brown, and from its margin the relatively short parapodia (*p.*) arise. The strongly developed pharynx (*ph.*) is situated at the same level as the parapodia, the middle portion alone is somewhat thick—but thinner than in *Myzostoma cirriferum*—and 1·7 mm. broad; it is surrounded by a yellow zone, ·45 mm. in diameter, which is occupied by the terminal ramifications (*i.*) of the intestine. On the inside of this lie the large oval suckers (*s.*). The marginal border is pale yellow, ·3 mm. broad, and quite visible as a distinct region, even with the naked eye. There are nearly 100 short obtusely pointed cirri, which are more regular than those of *Myzostoma caribbeanum*; only a few are quite small, the majority being long and measuring ·046–·14 mm. Since none of the six specimens that I examined were absolutely intact, the number of cirri cannot be exactly stated; a great many in the smaller individuals were broken off. The marginal border also and the intestinal zone, being extremely thin and delicate, were much injured.

The mouth (*m.*) and cloacal aperture (*cl.*) are situated at the level of the external

margin of the suckers; the male genital openings (δ), but little prominent, lie still further inwards.

The largest specimen was dredged at St. Vincent (Station 224 of the "Blake" Expedition); it is 4 mm. in length, and considerably stouter and less transparent than the specimens described above. The intestinal zone is ribbed on the ventral side; the intestinal branches form externally elevated crests.

Host.—*Actinometra pulchella*, Pourt., sp., from Station 210 (Martinique) and Station 224 (St. Vincent) of the "Blake" Expedition. Another specimen came from Station 269 (St. Vincent) of the "Blake" Expedition, and probably from *Actinometra pulchella*, which occurred also at this Station.

45. *Myzostoma elegans*, Graff.

Myzostoma elegans, Graff, Genus Myzostoma, p. 12, pl. x. figs. 1–3.

I have only one specimen of this form, which was brought up by the "Bibb" Expedition, off French Reef, on *Actinometra meridionalis*. In diameter it was 2 mm.; the cirri were rather damaged.

Hosts.—(*a*) *Antedon triquetra*, Semper, MS., Bohol (Philippines).

(*b*) *Actinometra parvicirra*, Müll., sp., Bohol (Philippines).

(*c*) *Actinometra meridionalis*, A. Ag., sp. "Bibb" Expedition, April 3, 1869, off French Reef.

46. *Myzostoma antennatum*, n. sp. (Pl. VIII. fig. 1).

I received a single specimen from the Kiel Museum. The figure I have given is somewhat restored; the edges were so folded and pressed together that I found it necessary to divide the animal longitudinally, and then to draw each separate half; many of the long cirri which were injured by this process were completed by the help of their bases of attachment, and a comparison with the remaining intact cirri. The body is as stout as that of a well-developed *Myzostoma cirriferum*, and is darkish brown in colour; the median part of the body is opaque, but the marginal zone between the suckers (*s.*) and the border is thinner and slightly transparent, without being distinctly marked off from the rest. In life the body must have been circular; its length is 1·4 mm. The parapodia (*p.*) are well-developed, and stand in the middle line between the centre and the margin; the round conspicuous suckers are at about the end of the middle third of the radius. The mouth (*m.*) lies far inwards behind the foremost pair of parapodia; the strong pharynx, provided with papillæ, extends some way out of it. The cloaca (*cl*) is ventral in position, and lies in the more transparent marginal zone between the suckers and the edge of the body. The first, second, and last pairs of cirri are distinguished by their considerable length and size, as well as by their greater distance from each other. The first and last pairs are about 1 mm. long, the

second (anterior) pair are about ·6 mm. long, while all the rest are of equal size, and measure ·2 mm. The character of the cirri in this species recalls those of *Myzostoma brachiatum* (Genus Myzostoma, pl. ii. fig. 2).

Host.—Uncertain. Brought from Amoy by Dr. Gärtner, May 1877; Kiel Museum.

47. *Myzostoma cornutum*, Graff.

Myzostoma cornutum, Graff, Genus Myzostoma, p. 15, pl. x. figs. 4, 5.

Host.—*Antedon triquetra*, Semper, MS., Bohol (Philippines)

48. *Myzostoma brachiatum*, Graff.

Myzostoma brachiatum, Graff, Genus Myzostoma, p. 16, pl. ii. fig. 2.[1]

Host.—*Actinometra nigra*, Semper, MS., Bohol (Philippines).

49. *Myzostoma fissum*, n. sp. (Pl. IV. fig. 1).

The figure given of this species is enlarged seven times, and only pretends to approximate accuraey, since the only specimen at my disposal was so bent and rolled up that I was unable to extend it. Nothing can therefore be said about the ventral side. I shall merely describe, as well as possible, the dorsal side. In possessing large and deeply excised caudal appendages this species resembles *Myzostoma lobatum*, but differs in having six of them instead of four.

In both species there is a longitudinal furrow on the under surfaces of the caudal appendages. The colour is a dark brown. On the middle line of the back is a longitudinal crest, reaching from the obtusely terminating anterior end of the body as far as between the bases of the median longest caudal appendages. From the median crest five pairs of lateral elevations arise, which pursue an undulating course to the ten large prominent and pointed marginal serrations.

Host.—Uncertain (perhaps *Antedon inæqualis*, P. H. C.), from Station 174 (south-west of the Fiji Islands) of the Challenger Expedition.

50. *Myzostoma intermedium*, n. sp. (Pl. IV. fig. 2).

This unique specimen also was unfortunately so badly preserved that it was impossible to examine more than the contour. The body also was very much torn, and on account of its thickness but slightly transparent; only upon the margin, especially between the cirri, was it at all transparent. The colour is dark greyish-brown. The body is

[1] *Cf.* p. 8 of this Report.

circular in form, and about 2 mm. in diameter; the form of the cirri, which are, however, both relatively and absolutely larger, is like that of *Myzostoma quadrifilum*.

In the possession also of six caudal appendages it is intermediate between that form and *Myzostoma fissum*. The form of these appendages is like those of *Myzostoma quadrifilum*; they are divided into a larger basal part and a finer terminal thread (CA_1–CA_3). The last appendage (CA_3) that was not damaged measures from the margin of the body to the extremity 1·3 mm., the basal and terminal parts being of equal length. The second pair (CA_2) is somewhat shorter, and the exterior pair (CA_1) shorter still. The base of all the six appendages is continued for some way into the ventral surface of the disk. The slight development of the last pair of cirri (*c.*) is remarkable, compared to the rest,—they measure only ·45 mm.

Host.—*Antedon multiradiata*, P. H. C., from Station 187 (Torres Strait) of the Challenger Expedition.

51. *Myzostoma quadrifilum*, n. sp. (Pl. IV. figs. 3–6).

I had thirteen specimens, which I have united together under this specific name, and which came from the same host. The body is roundish, and terminates in four filiform caudal appendages, which differ from those of *Myzostoma quadricaudatum* in having a terminal thread. The light yellow marginal zone is distinctly marked off from the brown opaque middle portion. All the specimens, however, are not absolutely the same in regard to the length of the caudal threads and the form and length of the cirri; in some individuals the caudal appendages are entirely separated from their origin, in others they are united for a certain distance. There are, for example, two specimens measuring ·9 mm., in one of which the cirri are long, narrow, and slender, ·27 mm. long, and appear to be direct continuations of the margin, while in the other (figs. 5, 6) they are short, stout, and much wrinkled, measuring only ·1 mm. in length, and arise from the under side of the disk by a thick basal portion. I was prevented from making a strict distinction between the different varieties, from the fact that all the specimens, except those shown in figs. 3 and 4, were more or less injured or rolled up, and therefore unsuitable for an exact examination.

The smaller of the figured specimens (fig. 4) had a circular form, and measured ·7 mm., considering, as in *Myzostoma quadricaudatum*, the cloaca to be the termination of the body. The distinction between the disk and the caudal appendages is in this specimen very slightly marked, inasmuch as the basal parts of all the cirri are grown together, and the summits only are distinct. The intestinal cæca (*i.*) penetrate into the base of the caudal appendages—one into each. The mouth is subterminal; the cloacal opening (*cl.*) is placed on a slender papilla lying between the bases of the median caudal appendages. The pharynx (*ph.*) is moderately large, but I was unable to examine it in detail. The oval suckers (*s.*) are similar to those of *Myzostoma quadricaudatum*, and distant from the margin about

half their own diameter. The parapodia are well developed, the cirri about ·09 mm. long. The difference between this specimen and that shown in fig. 3 consists principally in the larger size of the latter; its body is about ·9 mm. long (measured to the point *X* where the median caudal appendage takes its origin; I could not find the cloaca); the length of the median caudal appendage is about 1·14 mm. As in the preceding species, the external caudal appendages are much smaller than the median ones. The median caudal appendages are grown together, while the exterior ones are free from their base upwards. The length of the last cirrus on either side (*c.*) is ·26 mm.; the rest are scarcely half as long. In all other dimensions this specimen (fig. 3) agrees with the first described specimen, the size of the pharynx, the parapodia, and suckers being of course actually larger since the specimen itself is larger.

Host.—Antedon bidentata, P. H. C., Station 186 (Torres Strait) of the Challenger Expedition.

52. *Myzostoma quadricaudatum*, n. sp. (Pl. V. figs. 5, 6).

The body is roundish and flat, light brownish in colour, and but slightly transparent; it has a length of 1 mm. and a breadth of ·9 mm., and bears twenty cirri, the first and longest pair of which measure ·23 mm., the rest averaging ·16 mm. The cirri are massive and end obtusely. The body terminates in four caudal appendages, every one of which contains an intestinal cæcum. They are of equal length (·4 mm.), and end obtusely. The parapodia (*p.*) are well developed, and contain strongly bent hooks (fig. 6); the round suckers (*s.*) are situated upon the margin. On a level with the suckers, between the fifth and sixth cirrus on either side, is the male genital aperture (♂), at the bottom of a shallow furrow. The mouth opening is behind the anterior margin, the cloacal aperture is at the base of the bifurcation of the median caudal appendages. The extremely small size of the pharynx (*ph.*) is remarkable.

Host.—Antedon fluctuans, P. H. C., from Station 190 (Arafura Sea) of the Challenger Expedition.

53. *Myzostoma lobatum*, Graff.

Myzostoma lobatum, Graff, Genus Myzostoma, p. 19, pl. ii. figs. 3, 4.

Host.—Actinometra fimbriata, Müll., Bohol (Philippines).

54. *Myzostoma bicaudatum*, n. sp. (Pl. V. figs. 2, 3).

This specimen, which is the smallest of the Myzostomida Caudata, measures ·45 mm. (without the caudal appendages); it is nearly circular in form, and flat on both sides. It is stout, hardly at all transparent, and brownish in colour; there is hardly any trace of a thinner lateral zone. The twenty cirri arise from the ventral side of the margin; in the only

specimen that I have they are nearly all cut off, but the stumps that have remained behind permit me to judge of their size. The longest cirrus (the first) measures ·16 mm., the shortest (fifth on the right side) measures ·03 mm.—commencing from the margin of the body.

The two caudal appendages are round and massive, becoming gradually smaller and arising from the ventral side; they end in an obtuse point. There is no terminal thread, and each contains an intestinal cæcum. They measure ·3 mm. from the margin of the body to their tip. The slender parapodia (*p.*) are prominent; the hooks are slight and not much bent at the tip (fig. 3). The small suckers (*s.*) are closely approximated to the margin of the body, and are flat and circular. The pharynx is remarkably thick and large, and measures nearly two-thirds of the length of the body; it extended some distance beyond the subterminally situated mouth. The cloacal aperture is, like the mouth, ventrally situated near the hinder margin and between the insertions of the two caudal appendages. Of sexual organs I could discover no trace, but there were a number of eggs round the intestinal cæca within the caudal appendages, which appeared to be unripe, and therefore mark out this specimen as a young one.

Host.—Actinometra meridionalis, A. Ag., sp., "Bibb" Expedition, January 16, 1869, west of Tortugas.

55. *Myzostoma filicauda*, n. sp. (Pl. V. fig. 4).

This species resembles more closely *Myzostoma bicaudatum* than the other species with two caudal appendages, viz., *Myzostoma filiferum*, firstly, by the strong development of these caudal appendages, and secondly, by the fact that the first and the last cirri are the longest. If it be really true that the terminal threads (see p. 8) appear with increasing age, it might well be supposed that this species is only an older stage of *Myzostoma bicaudatum*.

Moreover, among the seven specimens that I examined, all of which came from the same host, there was one about one-third smaller than the specimen figured, which differed from the rest in possessing no short terminal thread upon the caudal appendages. The specimens, however, were not well enough preserved to enable me to state this fact with entire confidence; possibly the terminal thread may have been torn off. In the meantime, therefore, I must consider *Myzostoma filicauda* as a distinct species.

The largest specimen (fig. 4) was 1·3 mm. long, and in breadth somewhat less. The only caudal appendage (the left hand one had been torn off) is 1·9 mm. long, and about one-seventh of this length is occupied by the terminal thread (*CF.*); it is cross furrowed here and there (*CA*). The tip of the terminal thread was wanting, and I have endeavoured, by comparison with other specimens, to compute its length. The greatest diameter of the caudal appendage is ·27 mm.; it contains a terminal branch (*i.*) of the

intestine, which extends as far as the terminal thread, and a number of eggs (*ov.*) closely pressed together. The two anterior cirri (*C.*) arise just in front of the mouth, and are ·4 mm. long; the second pair are ·12 mm., the last ·2 mm. The intervals between the cirri are fairly regular, but somewhat larger than the rest is the interval between the caudal appendage and the last cirrus. The body is dark brown coloured (yellower in some specimens), and much more massive than in *Myzostoma cirriferum;* at the same time it is brittle. Towards the outer margin it is more transparent; the elliptical suckers (*s.*), remarkable by their large size (·18 mm. greatest diameter), are closely approximated to the margin of the body. The parapodia (*p.*) are strongly developed, and often extend considerably beyond the margin of the body when the hooks are protruded. Above the third parapodium is visible on either side an oval vesicula seminalis, opening by the somewhat inconspicuous male genital aperture (♂).

The mouth is quite close to the anterior end of the body; it is ventral in position, and followed by a large pharynx apparently provided with papillæ (*ph.*). The cloacal aperture (*cl.*) opens on a conical papilla arising between the caudal appendages.

Host.—Antedon hageni, Pourt., "Corvin" Expedition, May 17, 1867; off Sandkey.

56. *Myzostoma filiferum*, n. sp. (Pl. V. fig. 1).

The body of this species is opaque and dark brown in colour, becoming gradually lighter and more transparent upon the margin; there are twenty short, obtuse cirri, which arise from a larger basal portion. The form of the body is nearly circular, and ·75 mm. in diameter; it terminates behind in two long caudal appendages, measuring more than 1·5 mm.; each of these is divided into a basal portion ·24 mm. long, which contains an intestinal cæcum and a fine terminal thread measuring 1·35 mm. The length of this terminal thread and the dimensions of the cirri mark out this species as distinct from *Myzostoma bicaudatum*, which it otherwise very closely resembles. The first and the last pair of cirri in the latter are relatively and absolutely larger than the corresponding cirri in *Myzostoma filiferum*, though the animal itself is smaller; in *Myzostoma filiferum*, in fact, these very cirri are the smallest ones of all.

Host.—Antedon bidentata, P. H. C., Station 186 (Torres Strait) of the Challenger Expedition.

57. *Myzostoma carinatum*, n. sp. (Pl. II. fig. 9, *A*, *B*).

I was able to examine only two not very well-preserved specimens—one from Martinique, the other from Mauritius. The following description relates to the latter, which is shown in the figure (fig. 9). The colour of the animal is lightish yellow, its length 1·8 mm.; it is somewhat cup-shaped on the ventral side. The thickness of the body is even, and is about the same as in a large specimen of *Myzostoma*

cirriferum; the consistency of the body is rather loose; there is no trace of any marginal border; there are more than twenty cirri about ·2 mm. long. On the dorsal surface is a longitudinal elevation crossed by furrows; from this seven pairs of wavy lateral elevations are given off, which radiate outwards to the periphery. The most anterior pair of these is the smallest, and is parallel with the middle one; the others increase in breadth and height towards the margin of the body, where they terminate abruptly.

The parapodia are slight; there was no trace of any suckers. The mouth is subterminal, as also apparently the cloaca, if I am right in what I take to be the cloaca. The Martinique specimen is about half as large; the circular contour of the body is more apparent, as it is not bent inwards; the dorsal elevations are less distinct; this specimen was worse preserved than the first.

Hosts.—(*a*) *Actinometra pulchella*, Pourt., sp., Station 193 (Martinique) of the "Blake" Expedition.

(*b*) *Antedon impinnata*, P. H. C., Mauritius, N. Bay, 15 fathoms; Kiel Museum.

58. *Myzostoma coronatum*, n. sp. (Pl. III. fig. 9, *A*, *B*, *C*).

This species is well marked by its characteristic shape and bright ochre-yellow colour. The largest of the four specimens examined is 3·2 mm. long and 2·2 mm. broad. The hinder portion is more obtuse than the fore part; the contour of the animal is oval. The back is much vaulted, but less so in the anterior part of the body, especially from the level of the second pair of cirri, so that it appears to be transversely furrowed when viewed from above and behind. Towards the margin the body becomes thinner and flatter, and ends in ten pairs of broad cirri, the length of which is about ·5 mm.; they are divided into a basal and distal portion of equal length. The dorsal surface is divided by longitudinal and transverse furrows into a number of quadrilateral elevations. In two specimens as large as that figured, the sides were bent down towards the ventral side; the dorsal elevations were not flat but tubercular, and further removed from each other. The smallest specimen is nearly circular (1·2 mm. long, 1 mm. broad), and is sculptured on the back like the individual first described, but the furrows are rather shallower, and hence the elevations less distinct.

The ventral surface (*A* and *B*) has a large longitudinal ridge instead of the typical central elevation; it commences at the subterminal mouth, and extends as far as the cloacal papilla, which projects a little beyond the margin of the body and may be seen from above. The large pharynx (*ph.*) was visible extending out of the mouth, and has behind its free margin a circle of papillæ. Since these are visible from above they appear like a serrated circlet on the anterior portion. The ventral side is covered by delicate transverse furrows. The parapodia (*p.*) are placed very far outwards, and are

feebly developed in proportion to the robust body. Outside the third pair of parapodia are the male generative apertures (δ), which project as small tubes. I could not find any trace of suckers.

Host.—Bathycrinus aldrichianus, Wyv. Thoms., n. gen. and sp., from Station 146 (west of the Crozets) of the Challenger Expedition.

59. *Myzostoma folium*, n. sp. (Pl. III. figs. 10, *A*, *B*, *C*, 11).

This elegant species is leaf-like in its general form, the anterior part of the body has a considerable diameter, which is gradually reduced until it terminates in a blunt point. The body is tolerably flat, but there is a slight dorsal longitudinal elevation. The dorsal surface is finely wrinkled and brown in colour; the marginal zone is transparent, yellowish in colour, and serrated.

On the ventral side the central part is even more sharply marked off from the marginal zone (*A* and *B*). The marginal zone is rather different from the same structure in other Myzostomida; it appears very much as if it were composed of a number of cirri fused together. The length of the single specimen is 5 mm., its greatest breadth nearly 2 mm. In the middle line of the ventral surface is a long narrow elevation running from the mouth to the cloacal aperture (*cl.*), which is distant one-sixth of the length of the body from its extremity. The pharynx (*ph.*) is very large, and extends some distance out of the mouth, measuring about one-fifth of the whole length of the body. The parapodia (*p.*) are strong and well developed; they are arranged in two parallel lines in the anterior part of the body. The last pair, however, are closer together, and arise quite near the median elevation. Each parapodium is divided by a circular furrow into a larger basal portion and a longer, but thinner, terminal part. On the latter there is a deep ventral furrow. In fig. 11 is shown the termination of one of the hooks. The point is somewhat bent and very strong; it shows upon its concave side a flat furrow; there was no trace of any suckers.

Host.—Antedon manca, P. H. C., Station 192 (south-west of Papua) of the Challenger Expedition.

60. *Myzostoma asymmetricum*, n. sp. (Pl. XI. figs. 4–8).

Mr. Herbert Carpenter observed a portion of an arm of *Pentacrinus alternicirrus*, two of the pinnules of which were larger than the rest; this portion is drawn from the side on fig. 4 *B*, which shows that these pinnules are twice as large as any of the others. The arms themselves are also slightly swollen in the neighbourhood of these pinnules (*), as may best be seen from the dorsal surface (*A*). On examining it, a yellowish coloured *Myzostoma* was found on the inner side of the enlarged pinnule (fig. 5). The parasite was not attached to the ambulacral side of the pinnule, though close to it, and the pinnule

therefore appeared to be asymmetrical (fig. 6 *B*,—6 *A*, section of the pinnule). Unfortunately the two specimens of this *Myzostoma* were not well preserved, and the margin especially showed traces of injury. The dorsal surface is slightly vaulted, as also the middle of the ventral surface (ideal section, fig. 8); the animal, although nowhere transparent, grows thinner by degrees towards the margin. The contour is oval, the length being 2·3 mm., and the breadth 1·4 mm. It is a noteworthy fact that one side of the body is longer than the other, and describes a greater arc (fig. 7), making the animal in this way asymmetrical. This asymmetry is connected with the position of the animal inside the pinnule; the side turned towards the marginal border of the pinnule, having more room to grow, is larger than that turned towards the ambulacral groove. We may also conclude that the parasite had remained within the pinnule from the very first.

The mouth and cloaca are terminal, and the pharynx is of considerable size. The parapodia are not much developed, and appear like small warts (*p.*), not more than ·16 mm. long; they are arranged in two longitudinal rows, and all the ten are at equal distances from each other.

Host.—*Pentacrinus alternicirrus*, P. H. C., Station 214 (south-east of the Philippine Isles) of the Challenger Expedition.

61. *Myzostoma pentacrini*, n. sp. (Pl. XI. figs. 9-15).

Of this species v. Willemoes Suhm[1] remarks, "Während Thomson die Thiere (verschiedene Arten grosser *Pentacrini* aus 500 Faden in der Nähe der Meangis-Inseln) selbst vornahm, untersuchte ich sie auf Parasiten und fand zwar keine freilebenden, aber desto mehr *encystirte* Myzostomen. Und zwar waren es diesmal nicht, wie ich früher einmal bei *Comatula* gefunden habe, ein grosses und ein kleines Individuum, die in einer Cyste zusammensassen, sondern 2–3 *gleich grosse offenbar geschlechtsreife Individuen*. Einige von den Pentacrinen sind ganz mit ihnen bedeckt und ihre Arme, deren Kalksubstanz da, wo die Cyste sitzt, resorbirt ist, in Folge dessen ganz brüchig. Freilebende Exemplare fanden sich niemals bei diesen mit Cysten behafteten Crinoiden, weder früher bei *Comatula* noch jetzt bei *Pentacrinus*, so dass es mir wahrscheinlich scheint, dass die Myzostomen sich alle zu einer bestimmten Zeit zu zweien und dreien an den Armen ihrer Wirthe einkapseln und begatten. Die Höhle, in der sie sitzen, steht wie gesagt durch ein Loch mit der Aussenwelt in Verbindung, und durch dieses werden wohl die Eier nach aussen entleert. Ob dann die jungen sich gleich wieder einbohren, was das wahrscheinlichste ist, oder ob sie eine Zeit lang frei am Kelch und den Armen des *Pentacrinus* leben, lässt sich noch nicht sagen."

These words no doubt refer to the species that I have just named. I examined two stained preparations of the animal which had been made by v. Willemoes Suhm; there were also two specimens, together with an individual of *Myzostoma deformator*, received from

[1] Brief VI. Von der Challenger Expedition, *Zeitschr. f. wiss. Zool.*, Bd. xxiv., 1876, p. lxxix.

Sir Wyville Thomson, and a number of portions of arms of *Pentacrinus*. This species does not produce real cysts upon the arms of its host, but only swellings of several (3–6) joints, which gradually disappear. In fig. 9 there is displayed a swollen arm viewed from the dorsal surface and from the right and left sides. The swollen segments of the arms are not placed so close together as in the normal healthy arm, and are irregular in shape, being sometimes partially replaced by intercalated plates; the basal pieces of the pinnules that arise from these joints are considerably enlarged. The cavity where the *Myzostoma* lives lies between two neighbouring joints; it opens on to the exterior by a slit which is bordered in an irregular fashion. If more than one *Myzostoma* be associated together in the same malformation, then the cavity of this is divided up into secondary cavities, one for each parasite. Thus in fig. 9 the swollen portion of the arm shows two cavities, separated from each other by a thick calcareous wall, and each opening by a separate aperture and ending in a tube-like prolongation on the ambulacral furrow. Fig. 10 represents the arm (fig. 9*C*) cut in the direction of the arrow and viewed from the distal end. In each cavity is a *Myzostoma*, with the anterior end turned towards the tube-like prolongation on the ambulacral furrow, and the pharynx extends out of the aperture. The swelling in one of the specimens in my possession occupied only two joints, a third joint being only slightly malformed; there was but one aperture on the dorsal side (fig. 15), and the cavity contained but a single specimen. The expression "absorption of the calcareous matter" used by v. Willemoes Suhm is not, in my opinion, happily chosen. There is in fact no absorption, but only a transference of the calcareous matter; it disappears inside in consequence of the growing *Myzostoma*, but is deposited again peripherally, and increases the thickness of the arm. Nor are the arms so brittle at the place occupied by the parasite as his description would seem to indicate; they appeared to me to possess as great a resistance as any of the other parts; the malformations, however, must interfere seriously with the mobility of the arm.

This *Myzostoma* (figs. 12, 13) is of a uniform brown colour, and like all the encysted forms has its lateral portions turned upwards, so that sometimes the marginal borders lie one upon the other (fig. 12); sometimes the dorsal surface appears to be reduced to a longitudinal furrow, so great is the folding of the sides of the body (cross section, fig. 14). Inside the cavity, the animal is placed with its ventral side turned towards the axis of the arm of the *Pentacrinus*, the dorsal fissure towards the periphery of the cavity, occasionally directly (fig. 9*B*) towards its opening.

The animal is rolled up in such a regular fashion that it becomes tube-like; from one end (fig. 13) projects the pharynx (*ph.*), and from the other the cloacal papilla (*cl.*), both being terminal in position. The parapodia (*p.*) are placed on each side in a semicircle, between the centre and the margin of the body; they are small, conical warts of ·2 mm. in length, and lie in shallow cavities.

Suckers are entirely absent. The form of the body when unrolled is circular, and

the margin is covered with short cirri, but the specimens were not sufficiently well preserved to enable me to fix the number; on the two specimens mounted and preserved by v. Willemoes Suhm (one is displayed in fig. 11) only a few cirri (*c.*) were to be observed. In these specimens, however, the abundant ramification of the intestinal cæca was very distinct; it is more abundant in this species than in any other. Cross sections show from twenty to thirty cæca on each side, irregularly branched. This rich ramification of the intestinal cæca, together with the form of the body and the existence of cirri, are the principal structural features that distinguish this species from the closely-allied *Myzostoma deformator*, with which it agrees in many other points, including the structure of the generative organs. It is, like the above-mentioned species, hermaphrodite, but differs from the typical free-living forms, in that the male generative opening and testis are only developed upon one side of the body; the testicular follicles are concentrated into a compact mass on one side, on the other there are only small rudiments of them, and the space generally occupied by these organs is filled with the highly-developed ovarian follicles.

The individual shown in figs. 12 and 13 was 3 mm. long, the breadth of the animal rolled up was 1·7 mm.

Host.—Pentacrinus alternicirrus, P. H. C., from Station 214 (south-east of the Philippine Isles) of the Challenger Expedition. There were fourteen specimens of *Pentacrinus* dredged at this Station, some of which were inhabited by several, some by many, specimens of *Myzostoma pentacrini*, and had the arms enlarged.

62. *Myzostoma deformator*, n. sp. (Pl. XII. figs. 1–9).

This species is parasitic in the pinnules, into which it bores its way in couples, causing them to become swollen and ovoid. This species is rarer than *Myzostoma pentacrini*. I examined four pinnules, three of which had the form shown in figs. 2 and 3, and no corresponding swelling of the arm-joint; in another one (figs. 4–6) the arm-joints (*a.–c.*) were swollen too.

The cysts have the same colour as the arm; their walls are calcareous, of considerable thickness and hardness, and may be recognised as malformed pinnules by their mode of attachment to the arm, especially when (figs. 2, 3) the ambulacral groove is continued along the whole length of the pinnule. The last-mentioned cyst measured 9 mm. in length, by 4·5 mm. in breadth in the middle, and ended in an obtuse point about 1 mm. in length, into which the concavity of the cyst did not enter. The arm itself was not much altered, either in form or consistence, the only alteration was a slight swelling of the joint bearing the malformed pinnule (fig. 3), and a shortening of the pinnule of the other side (fig. 2 *); but it cannot be said with any certainty that this last-mentioned alteration has anything to do with the parasite in the opposite pinnule. As is always the case in this species, the

cyst was lined by a tough brownish membrane, which in the middle of the cyst (in the direction of the arrow, fig. 2) on the antambulacral side is raised into a fold half as high as the cavity. Two equal-sized cavities communicating by a fissure are thus formed, in each of which was a *Myzostoma*, which did not, however, occupy the whole of the cavity; each lay on the ventral side of the cyst, at opposite extremities of the cyst, one near the point the other near the arm-joint; the proximal chamber (fig. 3) communicates with the exterior by a fine foramen. The second cyst had the same form and size, the third was similar but smaller by one-third, and was formed of numerous polygonal calcareous plates, the ambulacral furrow being bordered by several rows of them. The two parasites occupying this smaller cyst were, although small, evidently adult, for they were filled with eggs. This small cyst also enabled me to come to some conclusion respecting the growth and formation of the cysts. In all probability its growth commences by an enlargement of the joints of the pinnule; additional plates are subsequently intercalated, which, finally, when the parasite is fully developed, fuse together and form a solid wall, showing only traces here and there of its original composition (figs. 2, 3, 4, 6). The cyst displayed in figs. 4–6 (its point is broken off) differs from the others by its more rounded form, and by the two neighbouring arm-joints, as well as the one that bears the pinnule, becoming swollen. The hindermost of these (*c.*) has an enlarged pinnule—here broken off—whereas the anterior has lost its pinnule. The septum dividing the cavity of the cyst is longitudinal, it is attached to the wall only near the external orifice, and there is a fissure therefore left putting the two cavities into communication, but too small to allow the parasite to change its place. As in fig. 3 so also here (see the arrow, fig. 5), the aperture communicating with the exterior belongs to one of the two cavities only.

This species is found always in pairs in a single cyst, the individuals being of the same size and of a dark brownish colour and peculiar form (fig. 1). The lateral parts, as in *Myzostoma pentacrini*, are turned upwards at a sharp angle, so that in section the body is wedge-shaped (figs. 7, 8); the flat back of the wedge is formed by the ventral surface of the animal, and is bordered by the parapodia (fig. 1 *B*); the parts lying outside the parapodia are bent towards each other and form the sides of the wedge. The marginal borders being unprovided with cirri are apt occasionally to come into such close contact above that only a very narrow fissure is left, through which the dorsal surface of the animal can be discerned; sometimes the marginal borders are again bent outwards (fig. 1 *A*) in a lip-like fashion, so that a kind of tray is formed, the outer part of which corresponds to the ventral, the inner to the dorsal side of the animal.

Suckers are entirely absent, and the five pairs of parapodia are but slightly prominent as flat circular disks. The hook-apparatus is very feeble in proportion to the size of the animal, and the hook is only about half as long as the thickness of the body (fig. 7, *u*). The length of the specimen shown in fig. 1 (taken from the cyst, fig. 2), is 3 mm., the breadth of the flat ventral side, 2·4 mm. Considering that the bent portions of the

lateral margins are more than 1 mm. long, a total breadth of 4·5 mm. will be rather too little than too much, and in any case greater than the length, which, since the animal is turned up at both ends, will be at the most 4 mm. The body is thickest in that region that bears the parapodia (figs. 7, 8), the middle of the body being somewhat thinner and measuring ·5 mm. in cross section in an individual somewhat smaller than that represented in fig. 1. The alimentary canal is provided with a terminal mouth and cloaca, the stomach is very straight (*st.*), with rather slightly developed intestinal cæca (*i.*), nearly as in *Myzostoma glabrum*, but more richly branched terminally.

The dorso-ventral muscles (*dvm.*) are extraordinarily developed, but the hook muscles are very feeble, and since the musculi centrales (*mc.*) are but slightly developed, a ventral muscular mass is entirely absent. Testicular follicles (fig. 8, *t.*) are to be found only upon one side, where they exist in great numbers, but pressed into a compact mass. The corresponding region of the opposite side is occupied by ovarian follicles, which in this species do not occupy the whole body but only the central portion, so that a cross section, in the region of the first and last pair of parapodia for instance, shows but few ova (fig. 7, *ov.*), while in the middle of the body all the space unoccupied by the other organs is taken up by the ovaries (fig. 8, *ov.*). The highly vacuolated character of the ova (fig. 9, *b*) is remarkable. This is, I believe, caused by the alcohol having dissolved many of the yolk globules, thus leaving cavities in the protoplasm of the egg. These cavities increase in size and number as the eggs become more and more mature. In small unripe eggs (*a.*) they are but small and inconspicuous, and in the very youngest ova (fig. 7, *ov.*) absolutely no trace of any vacuolation is to be observed. Both the individuals inhabiting a single cyst are equally formed in reference to sex, and, as already mentioned, ova are to be found in both specimens accumulated on the back. Also there are numerous eggs to be found loose in the cyst, which find their way through the aperture to the exterior, either as eggs or as ciliated embryos, the females themselves probably never leaving the cyst.

Host.—Pentacrinus alternicirrus, P. H. C., from Station 214 (south-east of the Philippine Isles) of the Challenger Expedition. Five out of the fourteen gathered at this Station had cysts.

63. *Myzostoma cysticolum*, n. sp. (Pl. XIII. figs. 1–5).

Mr. Carpenter sent me four specimens of a variety of *Actinometra meridionalis*, A. Ag., sp., dredged during the "Hassler" Expedition, the arms of all of which showed peculiar swellings. There was only one cyst to be found on each arm (two specimens had two, one three, and one five cysts), situated from the base to the middle of its length. The cysts were all of the same colour as the skin of the ambulacral furrow, but rough and hard from the deposition of calcareous matter in their walls. Each cyst opened by a small orifice at one end, which, however, is irregularly situated with respect

to the disk, being sometimes turned towards it and sometimes away from it. The shape of the cysts, and their proportion to the parts of the arm is also quite different. Sometimes they are extended and sausage-shaped (fig. 2), sometimes more ovoid (fig. 1), sometimes (fig. 3) intermediate between these two forms; the cysts are never longer than 3 mm., or broader than 2 mm. Some lie longitudinally in the ambulacral furrow of the arm (fig. 2); some extend along the pinnule (fig. 3); some are independent, and only attached by one extremity (fig. 1), where the cyst is laid transversely over the arm and bent to the antambulacral side. One cyst arises from the ambulacral furrow, and becomes attached to two opposite pinnules growing along their bases. The great thickness of the wall of the cysts is shown in the section (fig. 4). Every cyst contains a large brown coloured female (♀) and a small yellowish dwarf male (♂). The latter is transparent, and lies with its ventral side close to the side of the cyst, and with the dorsal side turned towards the female. The female has its lateral parts bent up and touching on the dorsal side, so that a tube is formed, the exterior wall of which is formed by the ventral surface, while the dorsal side forms a canal which is trilateral in section, and contains numerous eggs (fig. 4, *x*). As in *Myzostoma inflator* and *Myzostoma murrayi*, so in both sexes in the present species the suckers are absent; the female has no parapodia, but in their place are traces of the hook-apparatus. In neither sex are there cirri; the mouth (*m.*) and cloaca (*cl.*) are terminal.

The most striking difference between this species and the other dicœcious species is, that the female possesses rudiments of testicles besides the ovaries, which together occupy all the available space between the alimentary canal and the body-walls. The rudiments of the testis are in the form of collections of small cells (*t.*), closely resembling the immature testicular follicles of hermaphrodite forms, situated beneath the intestine; the existence of these rudiments is interesting, inasmuch as this species forms therefore a link between the hermaphrodite and dicœcious Myzostomida.

The intestinal ramifications of the female (*i.*) reach almost to the margin of the body, and between them pass bundles of muscular fibres running from the dorsal to the ventral surface. The female is very firmly attached to the walls of the cyst, so that it was found impossible to detach one without injury. It appears to be circular in form, with a diameter of 2 mm. at the outside, and considerable thickness. The female shown in fig. 4 was ·6 mm. thick in the middle of the body, and ·2 mm. at the commencement of the lateral portions of the body.

The male (fig. 5) is smaller than usual. It is circular in form, with a diameter of ·8 mm. The compact testicles (*t.*), with the marginally situated genital apertures (♂), placed somewhat behind the middle of the body, and the intestinal canal (i_1–i_3, the cæca; *r*, the small rectum), are distinctly visible, and though I was unable to follow the intestinal cæca to their extremities, it appears that they differ from those of the female in not reaching the margin, but leave a large marginal zone unoccupied. The parapodia (*p.*) are small,

obtusely-pointed elevations, remarkable for the size of their hooks (·17 mm.) and manubria (·1 mm.), as well as for the powerful development of the hook muscles.

This same species was also taken during the "Blake" Expedition at Station 249 (Grenada). The cyst was quite similar in form and position to that shown in fig. 1, but smaller in size (only 1 mm. long and ·7 mm. broad), and of a more solid consistency. The parasites, though isolated and in a fragmentary condition, were evidently *Myzostoma cysticolum.*

Host.—*Actinometra meridionalis*, var. *carinata*, P. H. C., dredged by the "Hassler," January 22, 1872, off Cape Frio, and by the "Blake," at Station 249 (Grenada).

64. *Myzostoma tenuispinum*, n. sp. (Pl. XIII. figs. 6–16).

This species forms swellings on the arm-joints on the dorsal side, of ovoid or irregular shape; the ambulacral furrow and the pinnules are therefore left intact. There are cysts occupying only one arm-joint (fig. 13), whereas all the larger cysts occupy two joints; sometimes in this latter case the boundary line between the two swollen joints remains distinct, sometimes less visible on account of intercalated plates (figs. 12, 14, 16). This is especially the case with the extraordinarily large cysts formed at the axillary plates, just before the bifurcation of an arm, where a great number of intercalated plates form the wall of the cyst (fig. 15). The smaller cysts always have only one round or fissure-like aperture, whereas the larger cysts have two or three apertures, one of which is always larger, and may be called the main aperture (fig. 15, *x*), while the others are irregular, and seem, when present, to be owing to the spaces left between two adjacent plates (fig. 15, *y*, *z*). Each cyst contains a large female and a small dwarf male, the latter always near the main aperture, towards which also the pharynx of the female is turned. The interior of the cysts is always covered by a brownish membrane, which cannot easily be removed. The plates of the cyst are hard and calcareous; they are of considerable thickness, and adhere very closely to each other. Since the size of the cyst corresponds to the size of the individual within it, one may conclude that the large cysts are gradually formed from the small ones (fig. 13), by the growth of the parasite, the cavity becoming continued on to neighbouring arm-joints. The arm cysts of *Myzostoma tenuispinum* are sometimes found combined with the pinnule malformations produced by *Myzostoma willemoesii*, and cause a very peculiar and remarkable appearance. These will be more exactly described when I come to treat of *Myzostoma willemoesii.*

There were several cysts upon each of the hosts, partly near the distal, partly near the proximal end of the arm, but mostly in the middle portion. A specimen of *Antedon inæqualis*, P. H. C. (Station 170, Kermadec Islands, Challenger Expedition), had also a pinnule that contained *Myzostoma willemoesii*, and two small and two large cysts, one of which is shown on fig. 6, magnified seven times and viewed from both sides. At C there is this cyst opened containing a female (♀, seen from behind) and male (♂). The first

has a straight, tray-like back, vaulted towards the sides and from before backward, bearing the mouth at the end turned towards the ventral side (fig. 8, female seen from ventral side), whereas the obtuse cloacal papilla is to be seen at the hinder extremity exactly terminal. The ventral side forms an obtuse longitudinal keel, vaulted down to the marginal borders, and bearing on each side, arranged in a semicircle, a series of small, wart-like parapodia, measuring at the most ·1 mm. in length. The great thickness of the body is seen by the ideal cross section (fig. 9), and longitudinal section (fig. 10); both are in the natural position, with the dorsal side uppermost. The marginal borders are like those in the male (fig. 7), but not quite so conspicuous; they are curved like them, and provided with seven cirri on each side. The length of the female taken out of the cyst (fig. 6) was 2·5 mm., the breadth 2 mm. The male (fig. 7) belonging to it is quite flat and transparent; the transverse and longitudinal diameters of the disk are equal, measuring 1·2 mm. The mouth and anal aperture are terminal, the pharynx is half as long as the body; the middle intestine or stomach gives off on each side three main intestinal branches, the middle one of which is again divided into three smaller ones. The intestinal ramifications do not reach the margin of the body, but leave a considerable area unoccupied. The testes (*t.*) are round, compact glands; the male genital apertures (♂) are marginal, and situated just in front of the fourth cirrus. The unequal distances at which the cirri are placed from each other are more striking in the male than in the female; this fact, and the characteristic contour of the body, mark out the species. The parapodia (*p.*) are blunt and conical in form; their hooks are extremely delicate and nearly straight; they measure at most ·14 mm. Suckers are absent in both sexes.

Another individual of *Antedon inæqualis*, from the same locality, had two small cysts, one of which is represented in fig. 13, and the three arm-swellings represented in figs. 11, 12, 14. All the figures are magnified two and a half times, and figs. 11, 14 very closely resemble the cyst (fig. 6), from which indeed fig. 14 only differs by the remarkable cross arrangement on the arm (*A* from the side, *B* from the back). But fig. 12 is remarkable in that the cyst is not ovoid and vaulted, but flat on the upper side. The female taken out of the cyst (fig. 13) was 1·8 mm. long, the male ·8 mm.

From the same locality I have some more fragments of the arms of the same species, bearing cysts formed in the same manner.

Myzostoma tenuispinum is also found upon *Antedon angusticalyx*, P. H. C. (Station 214, south-east of the Philippine Isles, Challenger Expedition), of which species I had (1) a specimen with three large cysts of the same form, and arranged similarly to the cyst shown in fig. 6, all having but one aperture; (2) two arm-fragments, each bearing a cyst of similar appearance, but smaller; (3) two arms with cysts at the axillar-joints. The size and form of one of the latter may be seen by referring to fig. 15 *A–C*, where it is represented as magnified seven times; the other is quite similar in form, but somewhat smaller; both stand off from the arm, and the free end bearing the main aperture (*x.*) is

turned inward to the disk. Fig. 15 has, besides the main aperture, two other apertures, small orifice (*z*), and a remarkable triradiate fissure (*y*); the smaller cyst shows only one secondary aperture on the place where in fig. 15 *C* the fissure *y* is visible. The cyst (fig. 15), in spite of its large size, contained only a single pair of the parasites, but both were of a larger size than usual, the female 4 mm., the male 2 mm. in length; both were of a deep brown colour.

A single specimen, which had been mounted on a slide by Dr. v. Willemoes Suhm, and which was sent me by Mr. Murray, contained a male. It was labelled—"*Myzostoma.* The little individual of the parasite pair in the cavity of the *Comatula* arm." There were no remarks as to locality, but undoubtedly a passage from the third letter of v. Willemoes Suhm[1] refers to this species, since he, as is evident from his preparations, has not separated *Myzostoma tenuispinum* from the following species *Myzostoma willemoesii.*

Hosts.—All the cysts collected during the Challenger Expedition were found upon the following hosts:—

(*a*) *Antedon inæqualis,* P. H. C. (No. 62), Station 170 (Kermadec Islands). Two out of twelve specimens had cysts. One had four (two small and two larger), the other five (two small and three large ones), all in the first third of the arm. Station 174 (south-west of the Fiji Islands).—One out of five individuals had cysts (among them the compound cyst referred to of *Myzostoma tenuispinum* and *Myzostoma willemoesii*).

(*b*) *Antedon angusticalyx,* P. H. C., from Station 214 (south-east of the Philippine Isles). One specimen had three large cysts; there were also two arms, each from a different individual, and both furnished with a large cyst on its basal part (fig. 15); and two fragments each with one cyst.

(*c*) *Antedon basicurva,* P. H. C. (No. 61), from Station 170 (Kermadec Islands). One specimen (out of fourteen) had a single cyst (formed as fig. 6) in the proximal third of the arm. As I could not extend the arms of the Crinoid, which were strongly folded together, it is very possible that other cysts, though present, had escaped my attention.

(*d*) *Antedon incisa,* P. H. C. (No. 61A), from Station 170 (Kermadec Islands). There was a single cyst on one out of five individuals on the proximal third of the arm. Fig. 16 shows it twice the natural size (copied from P. H. Carpenter's plates). Station 174 (south-west of the Fiji Islands).—Two specimens of the Crinoid were dredged, but neither had cysts.

[1] Von der Challenger Expedition, Brief III., *Zeitschr. f. wiss. Zool.*, Bd. xxv., 1875, p. xxxi.: "Den kleinen Parasiten der Comatula, Myzostomum, fanden wir zuerst in Halifax und seitdem habe ich ihn oft bemerkt. Diesmal (*i.e.*, between Kermandek and Fidji Islands) aber unter eigenthümlichen Umständen unter denen er wohl noch nicht zur Beobachtung gekommen ist. Ich fand nämlich an den Armen einer Comatula aus 600 Faden Anschwellungen von der Grösse eines Schrotkornes No. 3. Eine kleine Öffnung führte ins Innere, das von einer zarten Haut ausgekleidet war, und hier fanden sich stets 2 Myzostomen, ein grosses Individuum, das viel dicker ist als irgend welche, die ich früher frei auf den Armen des Seesterns fand, und ein kleineres, das etwa nur ein Fünftel des vorigen misst."

65. *Myzostoma willemoesii*, n. sp. (Pl. XIV. figs. 1–8).

One of the Canada balsam preparations, which were made during the voyage by v. Willemoes Suhm, and sent me by Mr. Murray at the end of 1882, contained a large and a small *Myzostoma*, and was labelled "*Myzostoma*, one pair from *Comatula*-arm-cave, Kermadec." The specimens were deeply stained with carmine, and no doubt much squeezed, as could be seen by the numerous folds. Although not much more than the contour of the animal could be observed (figs. 1, 2), it was evident that it was a new species. I received from Mr. P. H. Carpenter some additional material, which enabled me to study the form of the cyst. This species inhabits *Antedon basicurva* and *Antedon inæqualis*, P. H. C., and causes the pinnules to become spirally twisted; the margins of the spirals are in close apposition, forming a space in which the parasite lives, communicating with the exterior by an aperture at the point and by a fissure at the base. Fig. 6 represents one of these malformed pinnules in *Antedon inæqualis*, P. H. C., magnified five times, and fig. 7 shows the first three joints of this pinnule viewed from the inside (*A*) and from the outside (*B*). The ambulacral furrow is continued through the basal fissure into the interior of the cyst as far as its point. The single joints of the pinnule have, as may well be seen in fig. 7, a regular roof-shape, and each side, the one turned towards the arm, as well as the one turned away, is smooth and equal. In two cysts, however, of *Antedon basicurva*, P. H. C., and in one more than the other, the sides of the pinnule-joints that are turned towards the arm are longer than the others and irregularly notched (fig. 8, C). Each cyst contains a female and a male, the female being always the larger, and placed quite close to and with its ventral side attached towards the inner wall of the cyst. This species differs in many respects from the other dioecious cysticolous forms (*Myzostoma cysticolum*, *Myzostoma tenuispinum*, *Myzostoma inflator*, *Myzostoma murrayi*), and recalls the typical free-living forms, in that both male and female are furnished with powerful suckers and ten pairs of long cirri.

The female taken out of the cyst (fig. 6) is displayed in fig. 3, viewed from above, and in fig. 4 viewed from below. All the other cysticolous forms are turned upwards on both sides; but in this species it is the anterior and posterior ends of the body that are turned up, the mouth and cloaca therefore being also turned upwards. The diameter of the disk of the body, which is circular when extended, is 2·8 mm., the thickness in the middle is about the same as in a full-grown specimen of *Myzostoma glabrum*, but becomes less towards the marginal portion, which is therefore somewhat transparent. The ten pairs of cirri are not greater than ·15 mm. in length; the anterior parapodia, situated close to the mouth, are the smallest (fig. 3**); the parapodia are arranged in two longitudinal rows nearer to the middle line than to the border, and are at quite equal distances from each other (fig. 4, *p*). They are small and obtusely pointed, ·12 mm. long at the most,

The suckers (*s.*) are visible with the lens as small elevations, sharply marked off from the body, and are nearer to the margin of the body than to the parapodia.

The female, sketched from v. Willemoes Suhm's preparation, has a diameter of 2·2 mm., and the cirri, which are only preserved in part, measure ·27 mm. The preparation shows clearly the cup-like form of the suckers (S_1–S_4), the great breadth of the cloaca (*cl.*) and the mouth, and the extraordinarily developed pharynx. The bulbus musculosus of the pharynx (*ph.*) is 1·36 mm. long, and the free margin of the pharynx is covered by papillæ.

The male taken out of the same cyst (fig. 6) is shown in fig. 5. The interior organs, which are sketched in, were only to be seen on compressing the animal. The body is 1 mm. in length and rather stouter than in closely allied species, being thick and vaulted on the back, as in a specimen of *Myzostoma glabrum* of the same size, becoming, however, slightly transparent towards the border. The mouth (*m.*) and anal aperture (*a.*) are terminal; the pharynx (*ph.*) is not large; the twenty cirri are not longer than ·12 mm.; of these cirri the first and last pair are at a greater distance from those next to them, whereas the fifth and sixth are quite near together, enclosing the male genital aperture (♂). All that I saw of the testis appeared to show that instead of the compact organ of allied cysticolous forms, the organ retained the more primitive ramified character of the free-living Myzostomida.

The parapodia are stout and vigorous, and the hooks are correspondingly strong (·25 mm. in length). The suckers (*s.*) have the same form, arrangement, and relative size as those of the females. The male in v. Willemoes Suhm's preparation (fig. 2) is ·86 mm. long, and its cirri ·09 mm. long. The pharynx has a conspicuous circlet of papillæ.

It is an interesting fact that the malformations of the pinnules caused by this species sometimes combine with the arm-cysts of *Myzostoma tenuispinum*. I examined one compound cyst of this kind on *Antedon inæqualis*, P. H. C., and it may be seen from fig. 8, where it is displayed enlarged seven times, that the malformation of the pinnule is more striking than it is in the above-mentioned simple cysts of *Myzostoma willemoesii*. The basal portion alone, which represents nothing more than a lateral cavity of this portion of the arm, is inhabited by a pair of *Myzostoma tenuispinum*; it communicates by an aperture (fig. 8*B*) with the exterior, and is usually lined internally by a brownish membrane; it is separated from the part *b*, which is the malformed pinnule, by a calcareous partition passing in the direction of the arrow near *B*. In spite of its size, this part of the cyst contained only one pair of *Myzostoma willemoesii*. The ambulacral furrow is continued through the basal chamber *a* (fig. 8, *C*) into the chamber *b*; this last differs from the normal cysts of *Myzostoma willemoesii* (fig. 6), not only in the size of the pinnule joints, but also in that the interior slope of the joints (fig. 8, *C*) was much longer than the exterior; the margin also was prolonged into digitiform processes, covered with tubercles.

Host.—All the cysts were collected during the Challenger Expedition, and found on the following species of Crinoids :—

(*a*) *Antedon basicurva*, P. H. C. (No. 61), from Station 170 (Kermadec Islands). One individual had a single cyst on the proximal fifth of the arm. Another specimen out of the fourteen had a cyst of *Myzostoma tenuispinum*.

(*b*) *Antedon inæqualis*, P. H. C. (No. 62). Station 170 (Kermadec Islands). The specimen having four cysts of *Myzostoma tenuispinum*, had also one pinnule malformed by *Myzostoma willemoesii*. Station 174 (south-west of the Fiji Islands). A specimen with cysts of *Myzostoma tenuispinum* and also a combined cyst of this species and *Myzostoma willemoesii*.

66. *Myzostoma inflator*, n. sp. (Pl XV. figs. 1–4).

Fig. 1 represents a specimen of *Antedon angustiradia*, bearing at the commencement of two of the arms the cysts of this species. The cysts are pear-shaped, the thicker end being turned towards the disk and the thinner end being attached near the ambulacral furrow of the arms. The length of each cyst is about 3 mm., and they are connected with the arm along their whole length by a transparent delicate membrane. The wall of the cysts is hard and calcareous. In each cyst is a larger female individual and a smaller male, not unlike *Myzostoma murrayi*; in neither are the cirri or the suckers developed, and the female has no parapodia. From the opening of the cyst A the female projected slightly. In spite of its similarity to *Myzostoma murrayi* this species is evidently distinct; the female has a diameter about one-third less than the length; its contour is somewhat oblong, and the walls of the body are thin and delicate, so as to permit of the numerous intestinal cæca (fig. 3) and the ova being distinguished from the outside. The male (fig. 4) is provided like the female with a terminal mouth and anal aperture, and is similar in form. It differs from *Myzostoma murrayi*, not only in the structure of the intestinal canal, but also in the character of the testes, which are ramified through the whole body, after the manner of the free-living species, instead of being concentrated into a rounded and compact organ, as in *Myzostoma murrayi* and other cysticolous species; the genital openings also are not marginal but seem to be on the ventral side and further inwards than usual. I am unable to make any more exact statements, since the lateral portion of the specimen was rather injured, and also somewhat bent towards the ventral side. Some other specimens, from an *Actinometra* dredged at Barbados (Station 294 of the "Blake" Expedition), were in a better condition for examination. The cyst here was sausage-shaped, extending in a radial direction from the mouth to the border of the disk, about 3 mm. in length, and with a hard, rough wall. It was completely fused with the disk of its host throughout its whole extent

(fig. 2, *C*), and had a small aperture at the outer end. The most remarkable thing about this cyst was that, although undivided by any septum, it contained two pairs of *Myzostoma inflator*, which were closely pressed together and filled up the whole of the interior of the cyst. One pair was larger than the other, the female measuring 2·2 mm. in length by 1·2 mm. in breadth, and the male (fig. 4) ·9 mm. in length by ·8 mm. in breadth.

The relative length as well as the form of the hooks was the same in both sexes as in *Myzostoma murrayi* from *Antedon radiospina*.

Hosts.—(*a*) *Antedon angustiradia*, P. H. C., from Station 192 (south-west of Papua) of the Challenger Expedition.

(*b*) *Actinometra pulchella*, Pourt., sp., from Station 294 (Barbados) of the "Blake" Expedition.

67. *Myzostoma murrayi*, n. sp. (Pl. XV. figs. 5–13).

I found the peculiar cysts of this species first upon *Antedon duplex*, P. H. C., from St. Vincent (Station 269 of the "Blake" Expedition). There were upon the disk of this crinoid, quite close to the mouth, two club-shaped cysts, shown diagrammatically in fig. 8. The free end of the cyst projects between the arms on the dorsal side; the extremity is considerably thicker than the rest and bears an aperture. The larger of the two cysts measured 3·5 mm. long with a greatest diameter of ·86 mm., the width of the aperture being ·18 mm.; it was hanging down quite freely, whereas the smaller cyst was attached firmly to the disk for its whole length. The border of the cyst was tubercular, appearing to consist of numerous single calcareous plates united together by the solid membrane which lines the interior of the cyst. I had considerable difficulty in extracting the inhabitants of the cysts, and indeed only succeeded in getting some fragments from the larger one, since the parasites were very closely pressed into the various folds and furrows upon the inside of the cyst.

Mr. Carpenter, however, sent me a specimen of *Antedon radiospina* (Station 170, Challenger Expedition) containing two cysts of much larger size than the others. The first of these projected outwards and upwards from the ambulacral furrow at about the middle of the length of the arm; the second cyst was somewhat larger, placed in the same position on its host as the specimen from the "Blake" Expedition. This latter cyst is shown in fig. 9, *C*, magnified seven times; its length was 8 mm. Both these cysts were slightly connected along their whole length with the skin of the host. When the cyst was cut open lengthways, it was found to contain a female (fig. 10, ♀) which filled the distal two-thirds of the cyst, its dorsal surface being bent inwards; between the ventral surface of the female and the wall of the cyst, near the orifice, was a dwarf male (♂); the diameter of the body of the female, circular when fully stretched out, was 5·5 mm., its greatest thickness rather more than ·5 mm.; the whole body becomes thinner towards the margin, but is transparent throughout, and of a brownish colour. There was no trace of

suckers or parapodia visible, even by the help of a lens; the first are entirely absent and the latter are represented by a rudimentary hook-apparatus projecting but little beyond the surface of the body, and scarcely equalling in length the same structures in the male. Fig. 13 represents the manubrium (*ma.*) and the tip of a hook (*u.*) of the female, highly magnified; the obtuse form of the latter is remarkable, and is of course a sign of degeneration. Neither in the male nor in the female are any cirri present.

The male (fig. 11) is a thin transparent circular disk, 1·15 mm. in diameter by 1·3 mm. in length. The body of the female was quite full of eggs, which entirely prevented any minute examination into its structure; in the male the testes only occupy a small space on either side of the body, and do not conceal the other viscera. The genital aperture of one side (δ) is slightly withdrawn from the margin of the body; on the other side it is slightly prominent, and its margin is rather swollen. The alimentary tract is furnished with a terminal mouth and anus; the pharynx (*ph.*) is large and well developed, the rectum (*r.*) densely beset with fine long cilia; there are on either side three intestinal cæca (i_1–i_3), the terminal ramifications of which do not penetrate within the marginal border. Besides the pharyngeal valves, which are always present, there is another valve-like circular fold (*v.*), which divides the middle intestine into two parts. There are no suckers, but the parapodia (*p.*) are present as obtusely-pointed conical elevations, each enclosing a hook of ·2 mm. in length, which differs from that of the female in being pointed, and a manubrium ·15 mm. long. The cyst on the arm I did not open, as there appeared to be no doubt about its belonging to the same species.

Figs. 5 and 6 represent a stalked cyst from the disk of *Antedon angustiradia*, probably of this same species. It consisted of two hollow swellings separated by a groove; the stalk was solid. The whole length, including the stalk, was rather more than 5 mm. There was at the distal extremity a circular orifice with sharp edges. The structure of the wall was precisely as described in the other cysts, and only that side of the swelling which corresponded to the position of the opening was thinner and sufficiently transparent to allow of the large brown female being distinguished from the outside (fig. 5). It could also be seen through the aperture of the cyst. Its position within the cyst is shown diagrammatically in fig. 7; its form and structure, as far as I was able to judge, by help of the small fragments which I succeeded in getting out of the cyst, agreed with that of the female from *Antedon radiospina*, but the animal was hardly so large, its diameter being at the most 3·5 mm. In the same position as in *Antedon radiospina*, I found a dwarf male of the same form, but differing in the stronger curvature of the tips of the hooks.

Hosts.—(*a*) *Antedon angustiradia*, P. H. C., Station 192 (south-west of Papua) of the Challenger Expedition.

(*b*) *Antedon radiospina*, P. H. C., Station 170 (Kermadec Islands) of the Challenger Expedition.

(*c*) *Antedon duplex*, P. H. C., Station 269 (St. Vincent) of the "Blake" Expedition.

Stelechopus, n. gen.

The body is flat and long, the mouth at the anterior margin, the cloaca at the posterior; alimentary canal with no ramified cæca. Five parapodia on each side on the margin of the ventral surface, each one of which contains a fine long hook, and a supporting seta. The parapodia are entirely independent of each other, the parapodial muscles being very simple, and the radial musculi centrales, connected in the genus *Myzostoma* with a central muscular mass, are here absent. Instead of the radial muscular bundles (septa), there are numerous parallel muscular bundles joining the intestine to the body-wall. Suckers are wanting.

68. *Stelechopus hyocrini*, n. sp. (Pl. XVI. figs. 1–7).

The principal features in the organisation of this, the only species of *Stelechopus*, are stated in the generic definition. It appears to be undoubtedly the lowest form of Myzostomida, and ought therefore to decide the question concerning the affinities of the group with certain lowly organised Arthropoda (Tardigrada, Linguatulida). This affinity was formerly brought forward by me (Genus Myzostoma, p. 71), and I there proposed to unite the three groups into a single Class—Stelechopoda. It is therefore greatly to be regretted that the only specimens (nine individuals mounted in Canada balsam by v. Willemoes Suhm) which I received from Mr. Murray in November 1882, do not permit of an accurate study of the anatomy of this form. Any one having at his disposal abundant fresh material could undoubtedly render a great service to science.

Fig. 1 is a drawing which shows all that could be made out from all the different specimens; it is a combination figure. The specimen, however, from which the contour was drawn had been greatly squeezed, and the figure therefore does not give a right idea of the external form, and must be supplemented by a comparison with figs. 2–4.

The body when extended has a general similarity to a Tardigrade; the lateral margins are nearly parallel, and become somewhat narrowed at either end of the body. The anterior extremity is sometimes conical in form and highly prominent (fig. 1), sometimes retracted, and then looking as if truncated; the posterior extremity always projects as a conical caudal appendage (*CA*) between the last pair of parapodia. The largest specimen measured 3·5 mm. long with a greatest diameter of ·9 mm., the smallest was 1 mm. long and ·34 mm. broad. The caudal appendage of the former had a length of ·07 mm., of the latter ·06 mm. The body is flattened, and covered by a chitinous cuticle, reaching a thickness here and there of ·006 mm. in the largest specimen, highly refracting and yellowish in colour. Towards the mouth and cloaca, and at the end of the parapodia

(fig. 6), the cuticle becomes considerably thinner. Below the cuticle is a layer of polygonal epidermic cells from ·06–·01 mm. in breadth, and a muscular layer consisting of circular and longitudinal fibres. The circular fibres are extremely fine, and closely pressed together, whereas the longitudinal fibres are somewhat stronger, and separated by intervals. In specimens that have been but little squeezed, the integument is thrown into circular folds, sometimes interrupted by longitudinal folds, so that the surface is divided into ranks of large papillæ, which were especially well seen in a specimen (fig. 5) viewed with its dorsal side in profile, and in which the papillæ are of various sizes up to ·017 mm. in height. This system of folds is continued on to the parapodia, which are provided throughout their length from base to tip with circular concentric folds; the parapodia (fig. 2 *p.*) are not distinctly marked off from the body, and show no trace of any division into two portions, which is so typical of the Myzostomata; they arise from the extreme margin of the ventral side. The third pair are the most strongly developed, the first and the last are the most feeble. The first pair are obtusely conical in form, and about ·2 mm. long in the largest specimens; their breadth at the base is about ·28 mm. Corresponding to the insignificant size of the parapodia, the muscles and hook-apparatus (fig. 6) are but slightly developed; the latter consists of a long, thin (·25 mm. long ·006 mm. thick), straight hook (*u.*), with a short tip suddenly bent back, and of a slightly bowed, somewhat shorter but thicker supporting rod (*ma.*), which ends in a point, and shows no trace of any manubrial plate. The muscular apparatus is very simple; it consists of a fan-like series of fibres (*m.*), passing from the base of the parapodium and the integumental parts surrounding it to the base of the hook-apparatus, which they entirely envelope, serving no doubt as protractors. In no specimen, however, was the hook-apparatus stretched out, and indeed it was not generally even so prominent as in fig. 6, the extreme point alone being visible. Besides these protractor muscles are a series of radial fibres (m_2) passing to the end of the parapodium, and appearing to be joined partly to the supporting rod and partly to the integument at the end of the parapodium.

A third group of muscles passes from the end of the supporting bristle to the base of the hooks (m_1), and corresponds to the musculi conjunctores of the typical Myzostomata.[1] The most striking peculiarity in the condition of the parapodial muscles of *Stelechopus* is the absence of a musculus centralis,[2] which in *Myzostoma* is the most powerfully developed of all the muscles of the body, and combines with the musculi centrales of the other parapodia to form the central muscle-mass. There is nothing of the kind in *Stelechopus*, and the parapodial muscles are quite independent of each other. This arrangement is, without doubt, more primitive than the radial arrangement found in the typical Myzostomata, where the body is divided by radial septa into twelve sectors (ten for the parapodia, two for the pharynx and cloaca). Instead of this there are in

[1] Genus Myzostoma, pl. viii. fig. 1, *cb.* and *cl.*

[2] *Loc. cit.*, *mc.*

Stelechopus numerous parallel muscle bundles (fig. 1, *mm.*), reaching on both sides from the intestine to the integument. The intestine (*i.*) is more simple in structure, and there is no development of lateral diverticula; the entire alimentary canal is a simple tube (*i.*) passing through the body; it is frequently constricted, and at each constriction there is often a slight bulging out, but there is not any regularity to be observed in the arrangement of those bulgings; only in one individual (fig. 2) there was at the commencement a rudimentary diverticulum divided into three branches. The mouth is sometimes a small transverse slit, and sometimes a conspicuous round aperture of ·16 mm. diameter (fig. 3, *m.*), situated below the anterior margin of the body. It opens into a muscular tube, the pharynx (*ph.*), which does not, as it appears to do in fig. 1, pass directly into the intestine at its commencement, but opens into it some way behind from above, so that there is an anterior blind prolongation of the intestine. In none of the specimens did this pharynx project out of the mouth. With regard to the terminal part of the alimentary tract, I got no certain results; however, the tube which opens at the end of the caudal appendage would seem to be the cloaca, since the intestine appears to be continued into it, and I observed a mass of granular crumbling substance, which I believe to be fæces, projecting from it; also a muscular tube opens into it from above (*od.*), which must represent an oviduct, since there were a number of eggs visible in it. If this interpretation be right, then there is exactly the same relation between the rectum and the oviduct as in the genus Myzostoma. Mature ova are seen scattered through the body as oval or round bodies of ·06–·1 mm diameter, with a nucleus of ·03 mm. and a nucleolus of ·008 mm. in breadth (fig. 7). There are also to be found at the sides of the body, between the intestine and the integument, numerous accumulations of cells, which are distinctly different from the eggs by their granular appearance and smaller and variable size; these may serve as male genital cells. Since the specimens were not very well preserved, I can say nothing positive about these cells, neither have I succeeded in finding the male genital openings. It is possible, therefore, that the male sexual products find their way to the exterior by way of the cloaca, and it would be of the very greatest importance to clear up this point, which has special bearings upon the affinities of the group with the Tardigrada. This is all that I have been able to make out concerning the structure of this highly interesting form; too little, seeing its great importance, but sufficient to warrant its separation from the other Myzostomida.

Host.—*Hyocrinus* and *Bathycrinus*, off Crozet Islands, 1600 (Station 147) and 1375 fathoms, Challenger Expedition.[1]

[1] The label on the two preparations of v. Willemoes Suhm is "*Myzostomum* from *Hyocrinus*, 1600 fathoms, off Crozet Islands," but the passage in his sixth letter, which undoubtedly refers to these specimens, says :—"Ausser diesen gewöhnlichen Myzostomen gibt es übrigens auf Crinoiden noch andere allerdings mit diesen verwandte Parasiten, die ich im antarktischen Meer bei den Crozet-Inseln auf den aus 1375 Faden heraufgebrachten Gattungen Hyocrinus und Bathycrinus fand, Myzostomiden die ich einst daheim in Musse zu bearbeiten hoffe" (*Zeitschr. f. wiss. Zool.*, Bd. xxvi. p. lxxix.).

Finally, I must say that two specimens of *Myzostoma* which I had in my possession were so badly preserved that it was impossible for me to give an exact description of them, nor could I determine with any certainty their affinity with any of the described forms. The first was taken from *Antedon tuberosa*, P. H. C. (No. 92), dredged at Station 210 of the Challenger Expedition (Philippine Isles), the second from an *Antedon* also (No. 21), from Station 219 of the "Blake" Expedition; this last specimen had some likeness to *Myzostoma cirriferum*.

A third species, belonging to the Copenhagen Museum, was spoiled before I could examine it. It came from a small form of *Antedon* from Wladivostock (Russian Amurland).

LIST OF THE MYZOSTOMIDA HERE DESCRIBED, ARRANGED ACCORDING TO THE SOURCES WHENCE DERIVED.

(Those marked with an asterisk were only obtained from the source under which they are mentioned.)

CHALLENGER EXPEDITION.

*Myzostoma horologium.**
*labiatum.**
echinus.
gigas.
*calycotyle.**
*compressum.**
*wyville-thomsoni.**
*dentatum.**
*fimbriatum.**
*fissum.**
*intermedium.**
*quadrifilum.**
*quadricaudatum.**
*filiferum.**
*coronatum.**
*folium.**
*asymmetricum.**
*pentacrini.**
*deformator.**
*tenuispinum.**
*willemoesii.**
inflator.
murrayi.
*Stelechopus hyocrini.**

Total 24 (20).[1]

DREDGING EXPEDITION OF THE U.S.S. "CORVIN," "BIBB," "HASSLER," and "BLAKE."

*Myzostoma longipes.**
*testudo.**
*marginatum.**
*brevipes.**
*areolatum.**
*pictum.**
crenatum.
vastum.
*agassizii.**
excisum.
irregulare.
*caribbeanum.**
*rotundum.**
*oblongum.**
*abundans.**
elegans.
*bicaudatum.**
*filicauda.**
carinatum.
*cysticolum.**
inflator.
murrayi.

Total 22 (14).

[1] *i.e.*, Twenty-four species in all, twenty of which belong exclusively to the Challenger Expedition.

Prof. C. Semper.

Myzostoma costatum.
* *pallidum.**
triste.
*dubium.**
*elongatum.**
*verrucosum.**
elegans.
*cornutum.**
*brachiatum.**
*lobatum.**

Total 10 (7).

Copenhagen Museum.

Myzostoma echinus.
*plicatum.**
gigas.
*lütkeni.**
triste.
*brevicirrum.**
irregulare.

Total 7 (3).

Kiel Museum.

*Myzostoma radiatum.**
cirriferum.
*moebianum.**
excisum.
*antennatum.**
carinatum.

Total 6 (3).

H.M.S. "Porcupine."

*Myzostoma alatum.**
gigas.
*pulvinar.**
cirriferum.

Total 4 (2).

British Museum.

Myzostoma triste.
*coriaceum.**

Cambridge (Mass.) Museum.

*Myzostoma nigrescens.**
crenatum.

H.M.S. "Triton."

*Myzostoma carpenteri.**
cirriferum.

Prof. E. Hæckel.

*Myzostoma rubrofasciatum.**
costatum.

Leyden Museum.

Myzostoma vastum.

"Willem Barents" Expedition.

Myzostoma gigas.

Norwegian Arctic Expedition.

Myzostoma gigas.

Mr. P. Herbert Carpenter.

Myzostoma cirriferum.

Prof. C. Th. v. Siebold.

Myzostoma costatum.

Dr. J. W. Spengel.

*Myzostoma chinesicum.**

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PLATE I.

PLATE I.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–17. *Myzostoma horologium*, n. sp.

Figs. 1, 2. The animal from the ventral side.

Fig. 3. Piece from a transverse section of the sucker. *cu.*, cutis; *dom.*, dorso-ventral muscles; *e.*, epithelium of the surface of the body; s_1., epithelium of the sheath of the sucker; *se.*, epithelium of the retracted sucker.

Figs. 4–14. Several variations in the pigmentation of the back.

Fig. 15. A hook from the parapodium.

Fig. 16. The supporting stalk, with its manubrium (*ma.*), the hook (*u.*) partly drawn.

Fig. 17. The supporting stalk after having been treated with alkali. The manubrium (*ma.*) and the outer layer of the stalk (*b.*) dissolved into a finely granular substance. The more resistent central part (*a.*) of the latter still preserved.

Figs. 18–24. *Myzostoma testudo*, n. sp.

Figs. 18, 19. Seen from the dorsal side, with the tubercles always in pairs, and the divided longitudinal elevation.

Figs. 20, 21. Seen from the ventral side.

Fig. 22. Diagrammatic cross section through fig. 19.

Fig. 23. A small individual with a somewhat different sculpturing of the back.

Fig. 24. Point of a hook-apparatus. *ma.*, manubrium of the supporting stalk; *u.*, the hook.

Figs. 25–29. *Myzostoma alatum*, Graff.

Fig. 25. The animal from the dorsal side.

Figs. 26, 27. The same from the ventral side.

Fig. 28. Diagrammatic cross section through fig. 27.

Fig. 29. Point of a hook-apparatus. *ma.*, manubrium of the supporting stalk; *u.*, the hook.

Fig. 4.

Fig. 5.

Fig. 1.

Fig. 9.

Fig. 10.

Fig. 6.

Fig. 7.

Fig. 2.

Fig. 11.

Fig. 12.

Fig. 8.

Fig. 15.

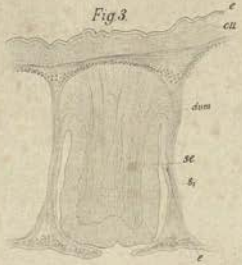

Fig. 3.

Fig. 13.

Fig. 16.

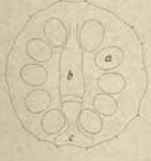

Fig. 18.

Fig. 20.

Fig. 17.

Fig. 14.

Fig. 19.

Fig. 21.

Fig. 23.

Fig. 22.

Fig. 28.

Fig. 24.

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 29.

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1-17. Myzostoma. horalogium. 18-24. M. testudo. 25-29 M. alatum.

PLATE II.

PLATE II.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camer and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–8. *Myzostoma gigas*, Lütken, MS. (1–6, Copenhagen Museum, 7, 8, Challenger Expedition).

Figs. 1, 2. From the ventral side; magnified 5 diameters.
Fig. 3. From the dorsal side; magnified 5 diameters.
Figs. 4–6. Its hook-apparatus. In fig. 4 the manubrium of the supporting stalk has been detached by the effect of the alkali; its outer layer (*b*) is stripped off, whereas the axis *a.* is intact.
Figs. 7, 8. Young individuals; magnified 7 diameters.

Fig. 9. *Myzostoma carinatum*, n. sp.

Fig. 9. The animal, seen from above (*B*) and from below (*A*).

Figs. 10–15. *Myzostoma carpenteri*, Graff.

Figs. 10, 11. The larger individual, seen from the dorsal and ventral side.
Fig. 12. Marginal cirri of the smaller individual.
Fig. 13. Marginal part of the larger individual.
Fig. 14. Diagrammatic cross section through fig. 10.
Fig. 15. Young stage attached to the back of fig. 10 (camera).

Figs. 16–19. *Myzostoma marginatum*, n. sp.

Fig. 16. From the dorsal side.
Figs. 17, 18. From the ventral side.
Fig. 19. Diagrammatic cross section.

Figs. 20, 21. *Myzostoma lütkeni*, n. sp.

Figs. 20, 21. The animal, seen from the ventral side.

Fig. 22. *Myzostoma pictum*, n. sp.

Fig. 22. The animal, seen from the dorsal side; magnified 16 diameters.

Fig. 23. *Myzostoma labiatum*, n. sp.

Fig. 23. The fore-end highly magnified, in order to show the papillæ of the mouth border (*mp.*).

Figs. 24–28. *Myzostoma longipes*, n. sp.

Fig. 24. From the dorsal side.
Figs. 25, 26. From the ventral side.
Fig. 27. Diagrammatic cross section through fig. 24.
Fig. 28. A complete hook-apparatus.

Figs. 29, 30. *Myzostoma echinus*, n. sp.

Fig. 29. Seen from the side.
Fig. 30. Seen from the ventral side.

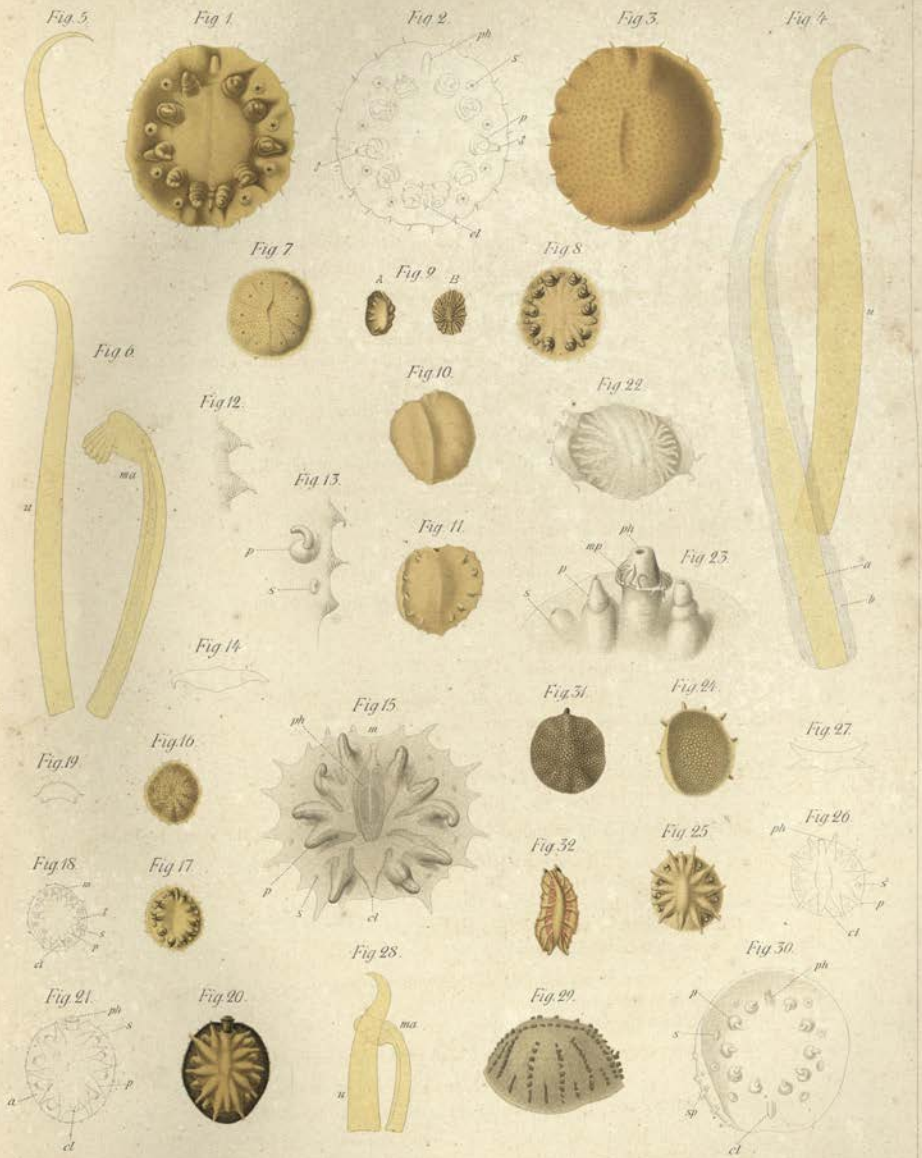
Both figures show the radial ranks of hard prickle-like tubercles of the skin.

Fig. 31. *Myzostoma chinesicum*, n. sp.

Fig. 31. The animal, seen from the dorsal side; magnified 6 diameters.

Fig. 32. *Myzostoma rubro-fasciatum*, n. sp.

Fig. 32. The animal, seen from the dorsal side.



1-8. Myzostoma gigas. 9. M. cirratum. 10-15. M. carpenteri. 16-19. M. marginatum. 20-21. M. luthiae. 22. M. pictum. 23. M. labiatum. 24-28. M. longipes. 29-30. M. echinus. 31. M. chinesicum. 32. M. rubrofasciatum.

PLATE III.

PLATE III.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*δ* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–3. *Myzostoma areolatum*, n. sp.

Fig. 1. From the dorsal side; magnified 60 diameters.

Fig. 2. From the ventral side.

Fig. 3. Diagrammatic cross section.

Figs. 4–8. *Myzostoma compressum*, n. sp.

Fig. 4. Part of the hook-apparatus.

Fig. 5. The animal seen from the side.

Fig. 6. Seen from above.

Fig. 7. Diagrammatic cross section.

Fig. 8. Part of the hook-apparatus.

Fig. 9. *Myzostoma coronatum*, n. sp.

Fig. 9. The animal, seen from above (*C*), and from the ventral side (*A* and *B*).

Figs. 10, 11. *Myzostoma folium*, n. sp.

Fig. 10. The animal, seen from the dorsal side (*C*), from below (*A* and *B*).

Fig. 11. Point of a hook.

Fig. 12. *Myzostoma radiatum*, n. sp.

Fig. 12. The animal, seen from below (*A*), and in diagrammatic cross section (*B*).

Figs. 13–15. *Myzostoma nigrescens*, n. sp.

Fig. 13. The animal seen from above, with one marginal border turned up.

Fig. 14. Hook-apparatus.

Fig. 15. An abnormal cirrus.

Figs. 16–18. *Myzostoma plicatum*, n. sp.

Fig. 16. From above.

Fig. 17. From below.

Fig. 18. Diagrammatic cross section; magnified 8–9 diameters.

Figs. 19, 20. *Myzostoma brevipes*, n. sp.

Fig. 19. Two individuals *in situ*.

Fig. 20. Diagrammatic cross section.

Figs. 21–23. *Myzostoma pulvinar*, Graff.

Fig. 21. From above.

Fig. 22. From below.

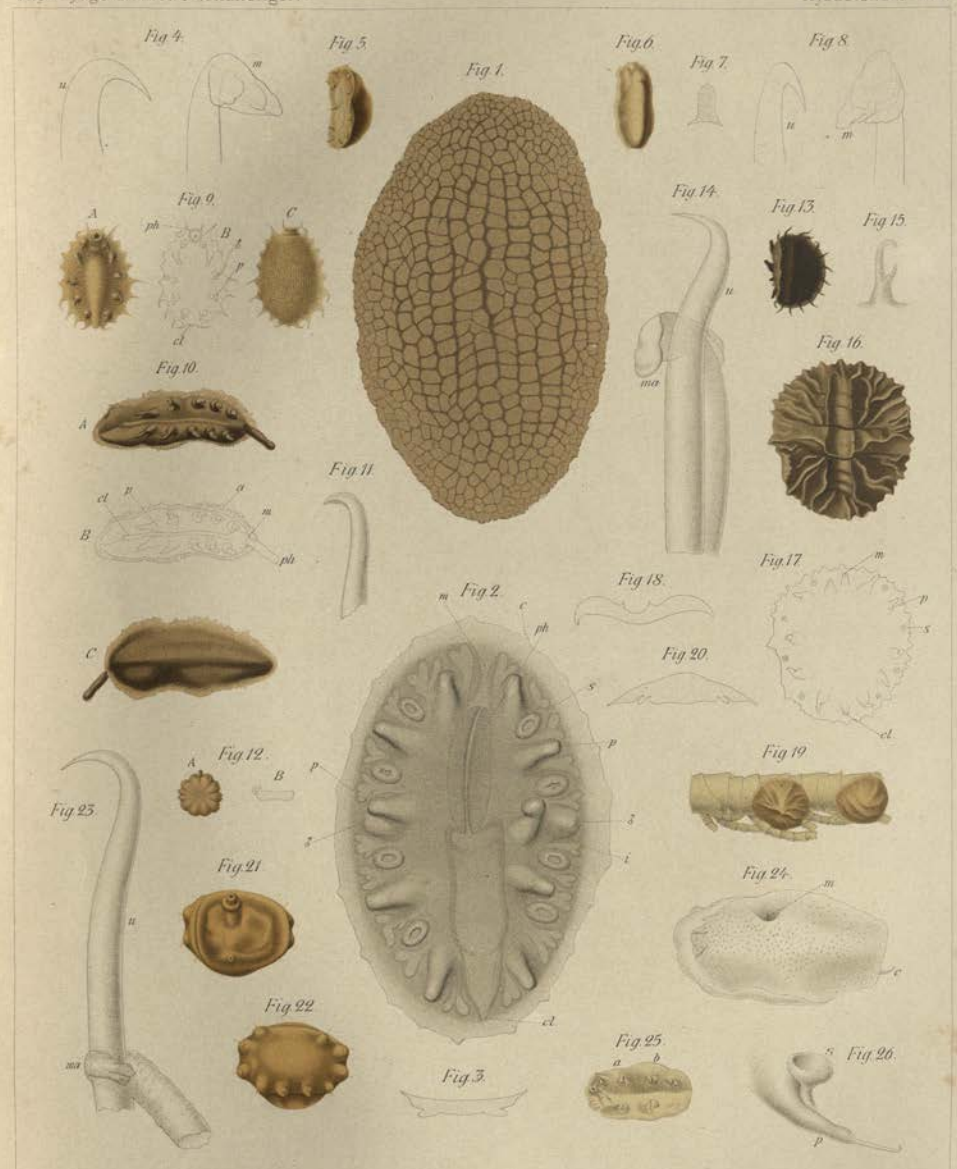
Fig. 23. Point of a hook-apparatus protruded from the parapodium.

Figs. 24–26. *Myzostoma calycotyle*, n. sp.

Fig. 24. The animal, seen from the dorsal side; magnified 15 diameters.

Fig. 25. The same, from the ventral side; magnified 7 diameters. *a.* and *b.* the foremost pair of parapodia.

Fig. 26. A parapodium and a sucker highly magnified.



1-3. Myzostoma areolatum. 4-8. M. compressum. 9. M. coronatum. 10-11. M. foliatum. 12. M. radiatum. 13-15. M. nigrescens. 16-18. M. plicatum. 19-20. M. brevipes. 21-23. M. palmiar. 24-26. M. calycocotyle.

PLATE VI.

PLATE IV.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma fissum*, n. sp.

Fig. 1. The animal seen from the dorsal side.

Fig. 2. *Myzostoma intermedium*, n. sp.

Fig. 2. Outline only. *C* the last pair of cirri; CA_1-CA_3, the caudal appendages.

Figs. 3–6. *Myzostoma quadrifilum*, n. sp.

Figs. 3, 4. Two individuals, seen from the ventral side.

Figs. 5, 6. Marginal cirri of another individual, more highly magnified; seen from above (6), and from below (5).

Fig. 2.

Fig. 1.

Fig. 3.

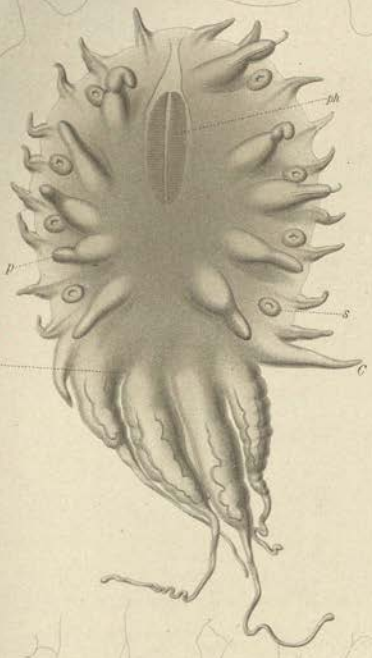


Fig. 5.

Fig. 6.

Fig. 4.

L. v. Graff fec. Lith. Anst. v. Werner & Winter, Frankfurt a/M.

1. Myzostoma fissum. 2. M. intermedium. 3-6. M. quadrifidum.

PLATE V.

PLATE V.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma filiferum*, n. sp.

Fig. 1. The animal, seen from the side, with the terminal threads (*CF.*) of the caudal appendages.

Figs. 2, 3. *Myzostoma bicaudatum*, n. sp.

Fig. 2. From the ventral side, with the obtuse caudal appendages (*CA*).

Fig. 3. The point of a hook.

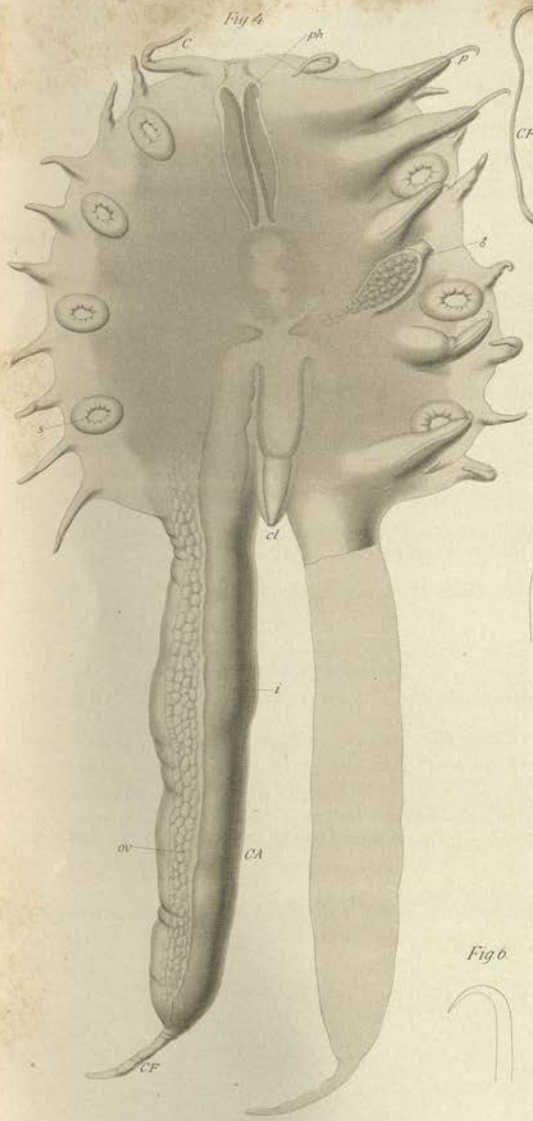
Fig. 4. *Myzostoma filicauda*, n. sp.

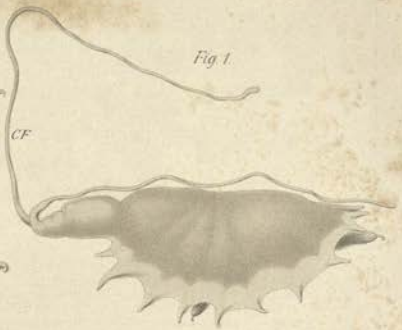
Fig. 4. The animal, seen from the ventral side, with the long caudal appendages (*CA*), and the short terminal threads (*CF.*). One of the caudal appendages was broken off, and is, like the point of the terminal thread *CF.*, hypothetically restored. In the same way the broken cirri in figs. 2 and 5 are restored. (The restored parts are distinguished by a lighter tint.)

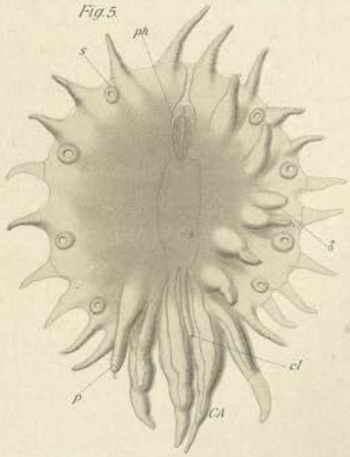
Figs. 5, 6. *Myzostoma quadricaudatum*, n. sp.

Fig. 5. The animal, seen from the ventral side.

Fig. 6. The point of a hook.







1 Myzostoma filiferum. 2-3. M. bicaudatum. 4. M. filicauda. 5-6. M. quadricaudatum.

PLATE VI.

PLATE VI.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1, 2. *Myzostoma wyville-thomsoni*, n. sp.

Fig. 1. The animal, seen from the ventral side.

Fig. 2. The point of a hook, much magnified.

Figs. 3, 4. *Myzostoma brevicirrum*, n. sp.

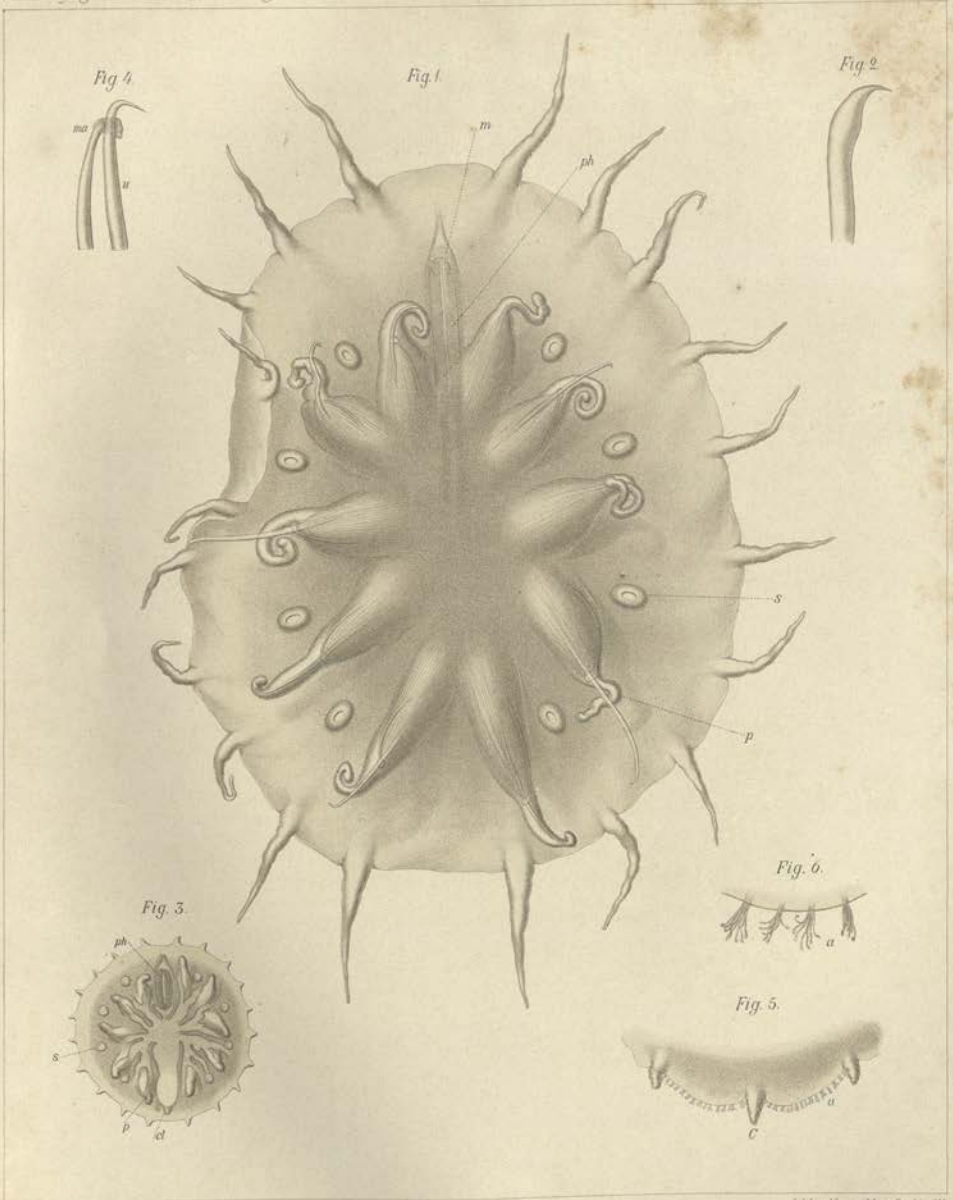
Fig. 3. The animal, seen from the ventral side.

Fig. 4. Hook-apparatus.

Figs. 5, 6. *Myzostoma fimbriatum*, n. sp.

Fig. 5. A piece of the hind border, with cirri (*C.*) and fringes (*a.*).

Fig. 6. Some of these fringes more highly magnified.



L. v. Graff Sc.

Lith. Anst. v. Werner & Winter, Frankfurt a/M.

1-2. Myzostoma Wyville-Thomsoni. 3-4. M. brevicirrum. 5-6. M. fimbriatum.

PLATE VII.

PLATE VII.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma agassizii*, n. sp.

Fig. 1. Marginal border turned inward to the ventral side.

Figs. 2, 3. *Myzostoma vastum*, n. sp.

Fig. 2. Animal seen from the ventral side, only half drawn.

Fig. 3. An abnormal cirrus.

Fig. 4. *Myzostoma crenatum*, n. sp.

Fig. 4. The animal, seen from the ventral side.

1 Myzostoma Agassizii. 2–3 M. rustum. 4 M. crenatum.

PLATE VIII.

PLATE VIII.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma antennatum*, n. sp.

Fig. 1. The outline of the animal restored by help of fragments, and the lost cirri completed.

Fig. 2. *Myzostoma excisum*, n. sp.

Fig. 2. The animal, seen from the ventral side.

Figs. 3–10. *Myzostoma mœbianum*, n. sp.

Fig. 3. The whole animal, seen from the ventral side.

Fig. 4. The anterior extremity with protruded pharynx.

Fig. 5. Ciliated cells of the rectum.

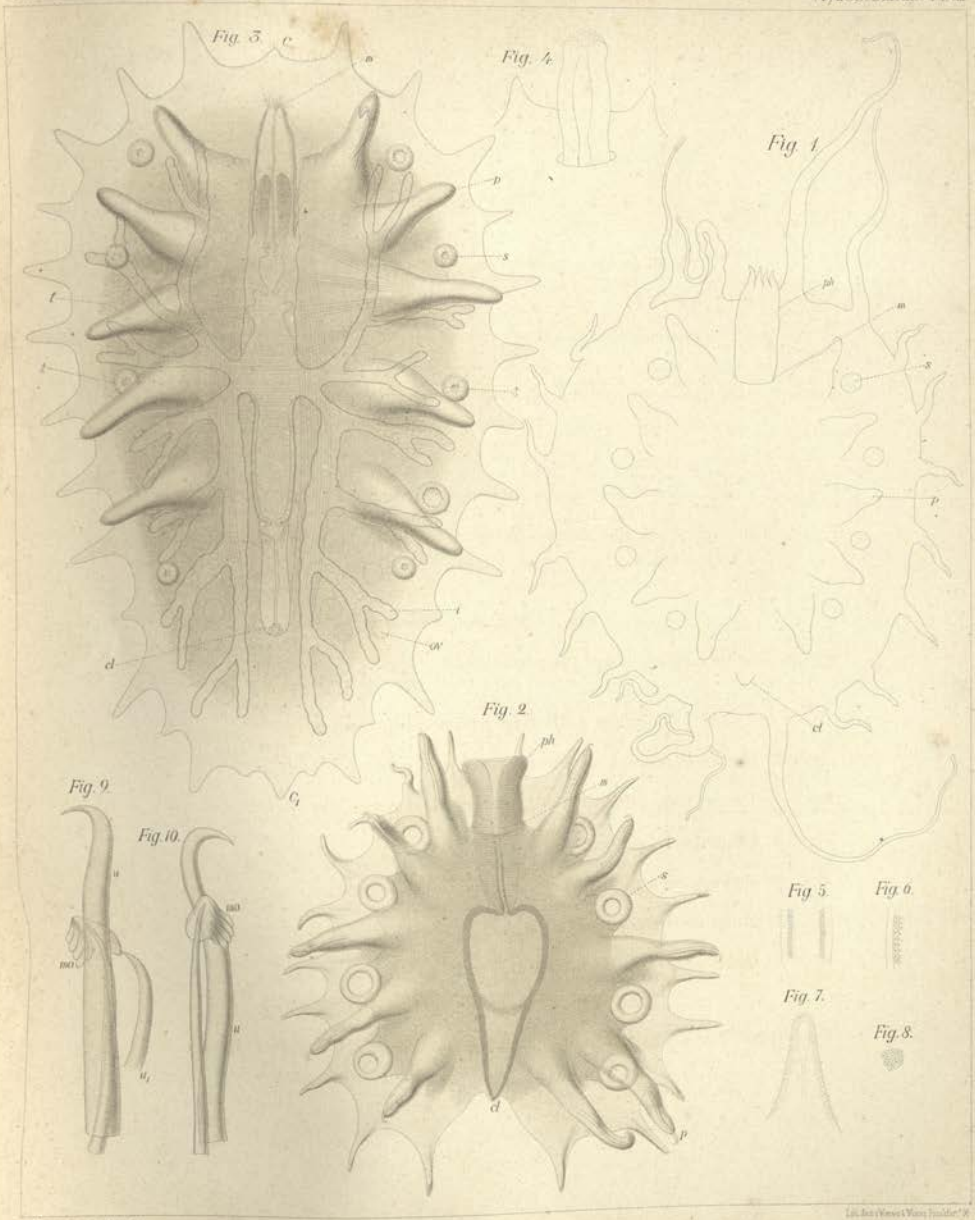
Fig. 6. Reddish cells in the stomach and intestinal branches.

Fig. 7. Marginal cirrus, much magnified.

Fig. 8. Cells of the skin, seen from the surface.

(Figs. 3–8 are from sketches by Prof. Möbius.)

Figs. 9, 10. Two hook-apparatuses, drawn from a preparation of Prof. Möbius.



K. Mohnike et L. v. Gaëll fecit.

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1. Myzostoma antennatum. 2. M. excisum. 3-10. M. Moebianum.

PLATE IX.

PLATE IX.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

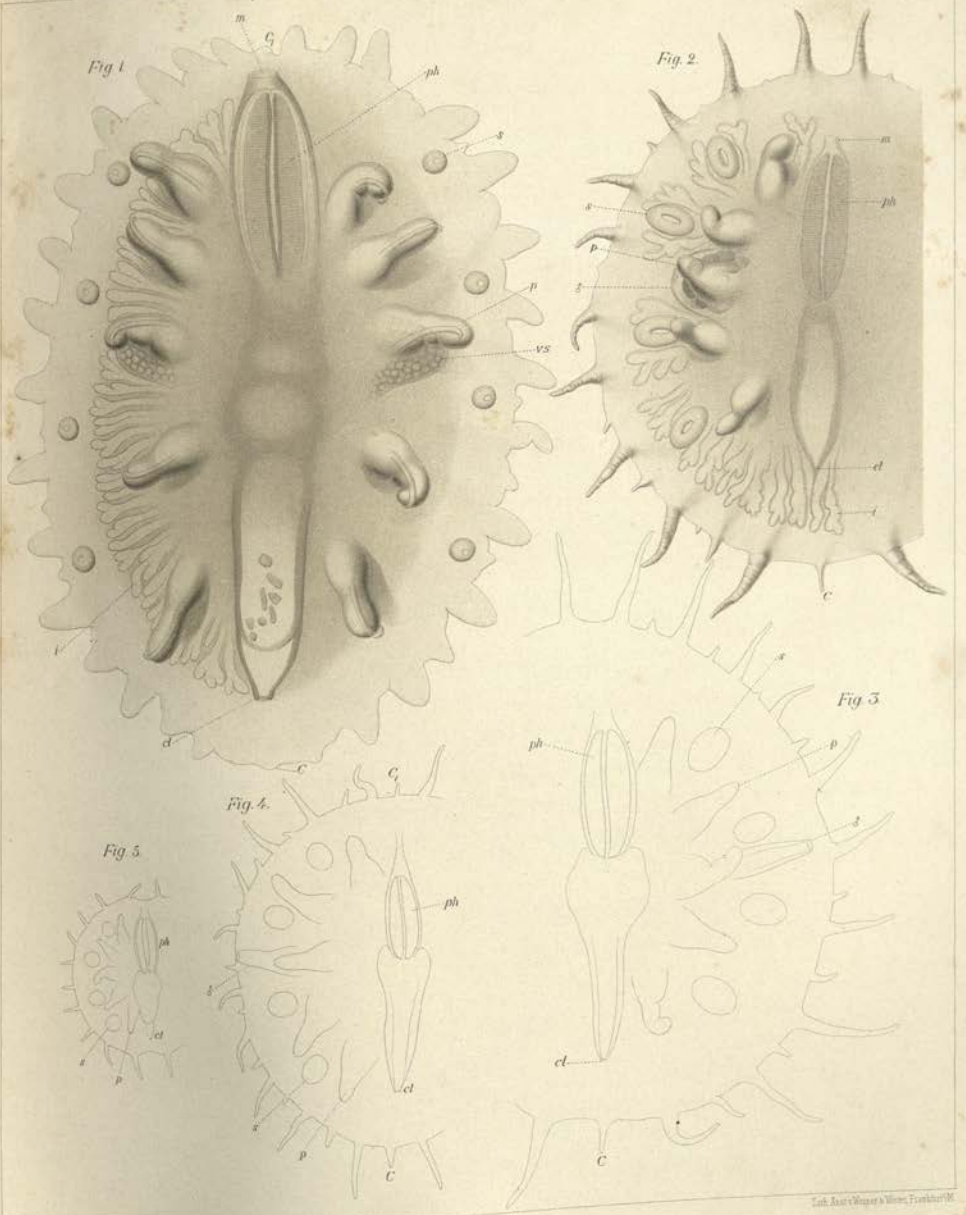
Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma dentatum*, n. sp.

Fig. 1. The animal, seen from the ventral side. C and C_1, unpaired median cirri.

Figs. 2–5. *Myzostoma irregulare*, n. sp.

Figs. 2–5. All the figures represent only one-half of the animal, with or without median cirri C and C_1.



Lv. Graff fec.

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1. Myzostoma dentatum. 2-5. Mirregulare.

PLATE X.

PLATE X.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Fig. 1. *Myzostoma abundans*, n. sp.

Fig. 1. The animal, seen from the ventral side; only half drawn.

Fig. 2. *Myzostoma rotundum*, n. sp.

Fig 1. The animal, seen from the ventral side.

Fig. 3. *Myzostoma oblongum*, n. sp.

Fig. 3. The animal, seen from the ventral side; only half drawn. The hind part of the body was quite destroyed, and is, as well as the last four cirri, hypothetically restored.

Fig. 4. *Myzostoma caribbeanum*, n. sp.

Fig. 4. The animal, seen from the ventral side; only half drawn.

Fig. 1

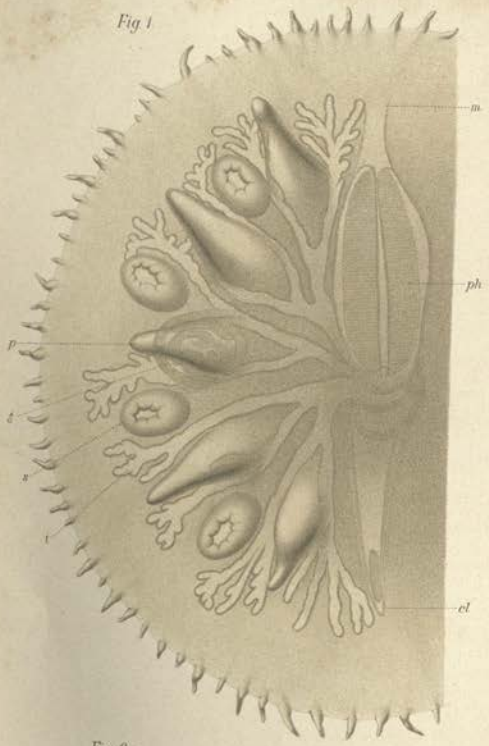


Fig. 2.

Fig. 3.

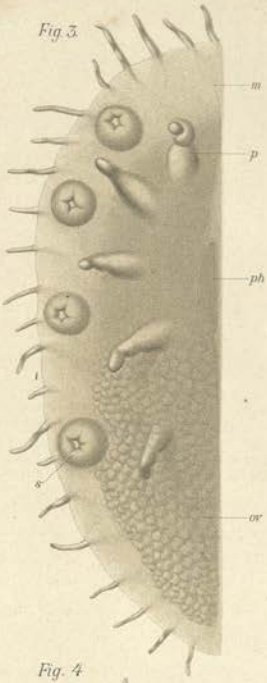
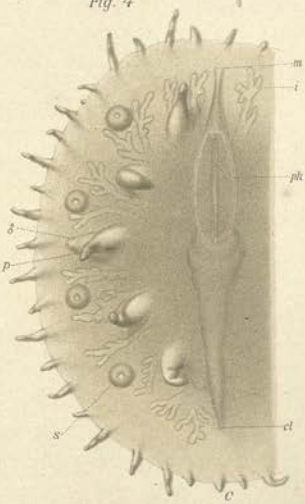


Fig. 4



1. Myzostoma abundans 2. M. rotundum 3. M. oblongum. 4. M. Caribbeanum

PLATE XI.

PLATE XI.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–3. *Myzostoma coriaceum*, n. sp.

Figs. 1, 2. The animal, seen from the ventral side.

Fig. 3. A diagrammatic cross section.

Figs. 4–8. *Myzostoma asymmetricum*, n. sp.

Fig. 4. Portion of an arm of *Pentacrinus alternicirrus*, P. H. C., magnified. From the dorsal side (*A*), and from the side (*B*), in order to show the swelling of the arm and the two pinnules (*) enlarged by the *Myzostoma*.

Fig. 5. The same without the pinnules of one side, to show the base of an enlarged pinnule, which base bears the *Myzostoma*.

Fig. 6. This pinnule from the side (*B*), and in cross section (*A*), in order to show the groove where the *Myzostoma* lay in contact with it.

Fig. 7. The *Myzostoma* from the ventral side; magnified about 28 diameters. In this figure the letters *p* and *ph* have been interchanged.

Fig. 8. Diagrammatic cross section through this *Myzostoma*.

Figs. 9–15. *Myzostoma pentacrini*, n. sp.

Fig. 9. Thickened portion of an arm of *Pentacrinus alternicirrus*, P. H. C. Seen from both sides (*A*, *B*), and from the dorsal side (*C*). The arm-joints *a-e* participate in the swelling. In *B* the *Myzostoma*, lying in a cyst, can be seen through the aperture in the joint *c*.

Fig. 10. The arm divided in the direction of the arrow (fig. 9, *C*), seen from the distal end. The two chambers, containing each a *Myzostoma*, are separated by a strong septum.

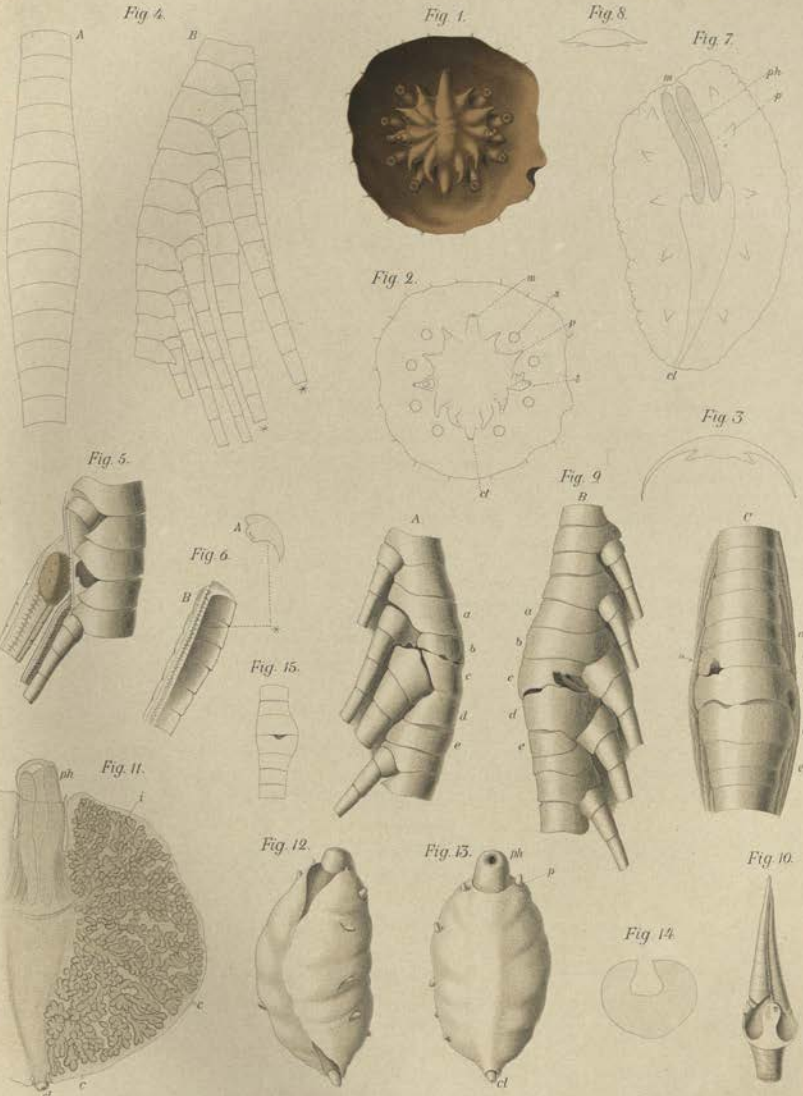
Fig. 11. The half of a squeezed preparation made by v. Willemoes Suhm to show the intestinal ramifications (*i*).

Fig. 12. The animal (fig. 9), seen from the dorsal side.

Fig. 13. The same, from the ventral side; magnified about 16 diameters.

Fig. 14. Cross section through another specimen.

Fig. 15. Another swelling of an arm of a *Pentacrinus* not so much magnified.



Lv Graff fec.

1–3 Myzostoma coriaceum. 4–8. M. asymmetricum. 9–15. M. pentacrini.

PLATE XII.

PLATE XII.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*♂* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–9. *Myzostoma deformator*, n. sp.

Fig. 1. The animal, magnified 5 diameters; seen from the dorsal side (*A*), and from the ventral side (*B*).

Figs. 2, 3. A swollen pinnule of *Pentacrinus alternicirrus*, P. H. C., from both sides. The arrow shows the direction of the internal septum; * is the injured pinnule lying opposite to the malformed one.

Figs. 4–6. Another malformed pinnule of *Pentacrinus alternicirrus*, P. H. C., from both sides, and broken open (5) to show the septum. Here also the three arm-joints *a–c* share in the swelling.

Fig. 7. A cross section through the *Myzostoma* in the hinder half of the body.

Fig. 8. A cross section about the middle of the body (camera, objective 0). *dvm.*, dorso-ventral muscular bundles; *e.*, epithelium of the surface of the body; *mc.*, musculus centralis of the hook-apparatus; *n.*, brain; n_1, nerves cut across; *od.*, oviduct; *st.*, middle intestine ("stomach").

Fig. 9. Isolated eggs of the ovarium. *a*, unripe, *b*, ripe ones (camera, objective IV.).

Fig. 1

Fig. 2.

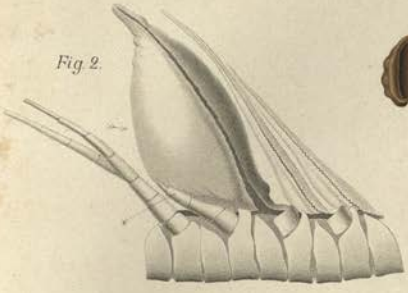


Fig. 3.

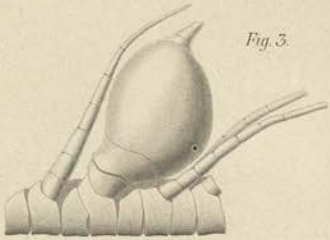


Fig. 9.

Fig. 4.

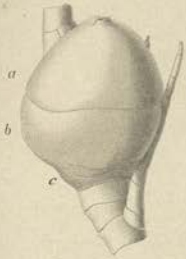


Fig. 5.

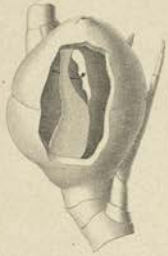


Fig. 6.

Fig. 7.

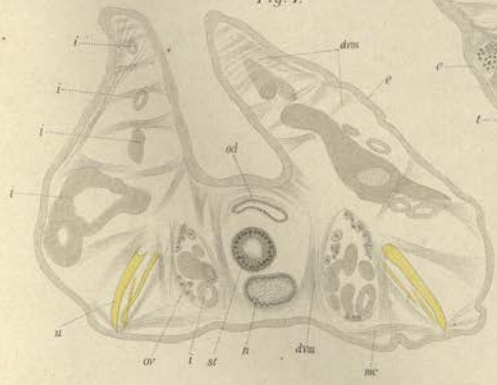
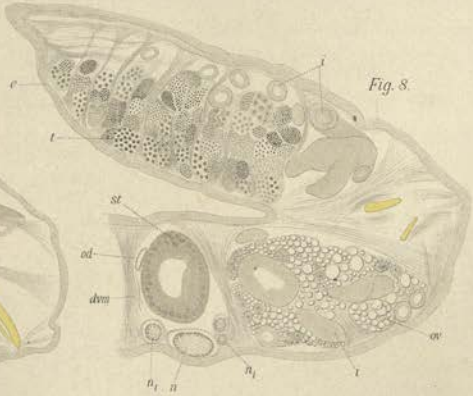


Fig. 8.



Lv Graff fec.

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1-9. Myzostoma deformator.

PLATE XIII.

PLATE XIII.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–5. *Myzostoma cysticolum*, n. sp.

Figs. 1–3. Three cysts from *Actinometra meridionalis*, var. *carinata*, P. H. C. ; magnified 5 diameters (figs. 1 and 3 drawn from both sides).

Fig. 4. Cross section through such a cyst, containing a dwarf male (♂) and the large female (♀). This latter is folded together, so that the lateral parts, lying quite close together, enclose a canal which serves as a "brood pouch" for the eggs.

Fig. 5. The dwarf male, seen from the ventral side; magnified about 75 diameters.

Figs. 6–16. *Myzostoma tenuispinum*, n. sp.

Fig. 6. A cyst from *Antedon inæqualis*, P. H. C. ; magnified 7 diameters. From both sides (*A*, *B*), and broken open (*C*), to show the male and the female within.

Fig. 7. The dwarf male, from the ventral side ; magnified about 75 diameters. *r.*, the rectum.

Fig. 8. The female, from the ventral side ; magnified about 12 diameters.

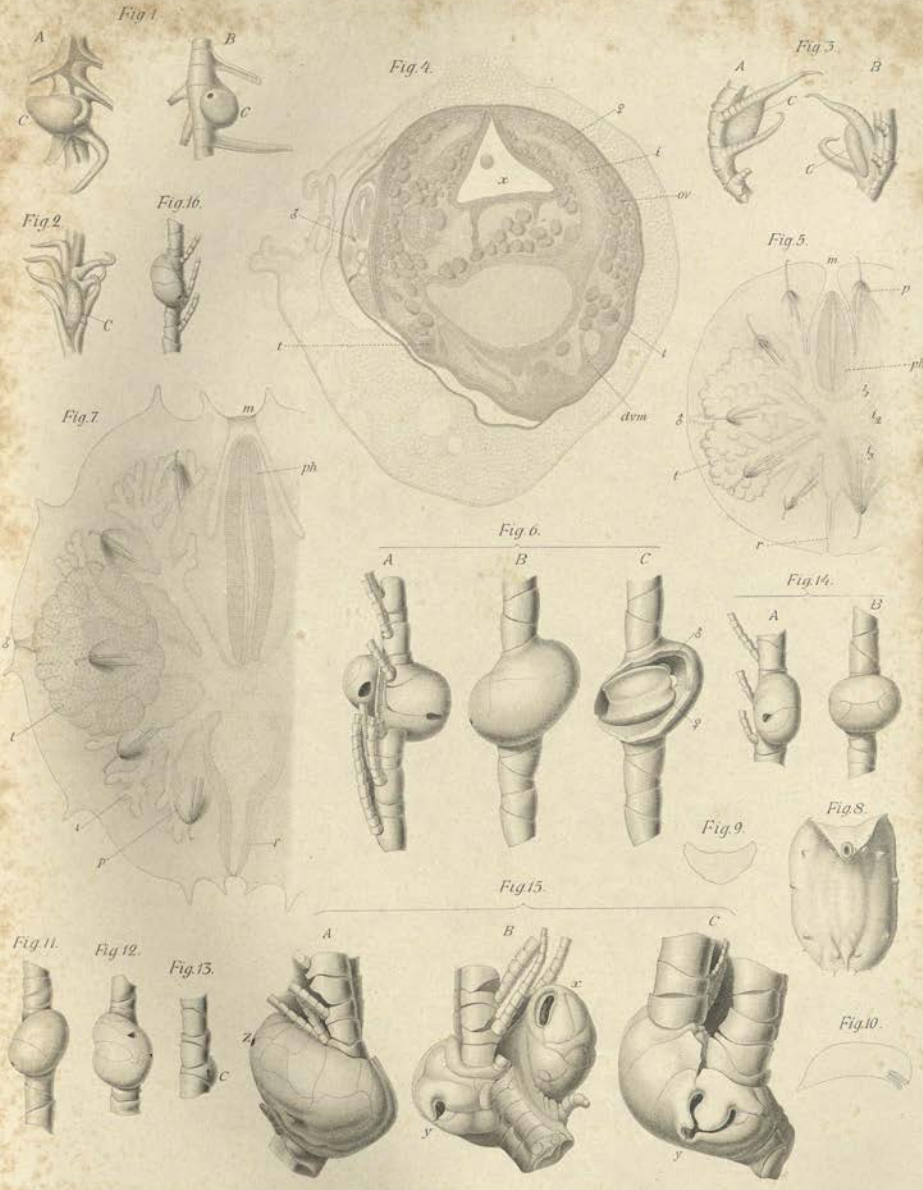
Fig. 9. Diagrammatic cross section of the same.

Fig. 10. Diagrammatic longitudinal section of the same ; the upper is the dorsal surface.

Figs. 11–14. Four other cysts from *Antedon inæqualis*, P. H. C. ; magnified 2½ diameters (14, *A*, from the side and *B*, from the dorsal side).

Fig. 15. A large cyst upon the base of an arm of *Antedon angusticalyx*, P. H. C., in three different views, magnified 7 diameters, having a main aperture (*x*) and two secondary apertures (*y*, *z*).

Fig. 16. An arm cyst of *Antedon incisa*, P. H. C., twice enlarged (copy of a figure made by Dr. P. H. Carpenter, and published here with his permission).



1-5. Myzostoma cysticolum. 6-16. M. tenuispinum.

PLATE XIV.

PLATE XIV.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	*ô* Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–8. *Myzostoma willemoesii*, n. sp.

Figs. 1, 2. Outlines of the female and of the dwarf male, from a preparation by v. Willemoes Suhm (camera, objective 0).

Figs. 3, 4. The female from the cyst fig. 6, magnified about 15 diameters; from the dorsal (fig. 3); and from the ventral side (fig. 4).

Fig. 5. The male belonging to it; magnified 75 diameters. On the left side the suckers, and on the right side the parapodia (from the second to the fifth) not drawn.

Fig. 6. Malformed pinnule of *Antedon inæqualis*, P. H. C.; magnified 5 diameters.

Fig. 7. The first three joints of this pinnule drawn from both sides.

Fig. 8. Another malformed pinnule of *Antedon inæqualis*, P. H. C., attached to the arm-joint *a* (also malformed). In this is contained a pair of *Myzostoma tenuispinum*, in the cyst of the pinnule *b* a pair of *Myzostoma willemoesii*, and both separated by a septum in the direction of the arrow; magnified 7 diameters.

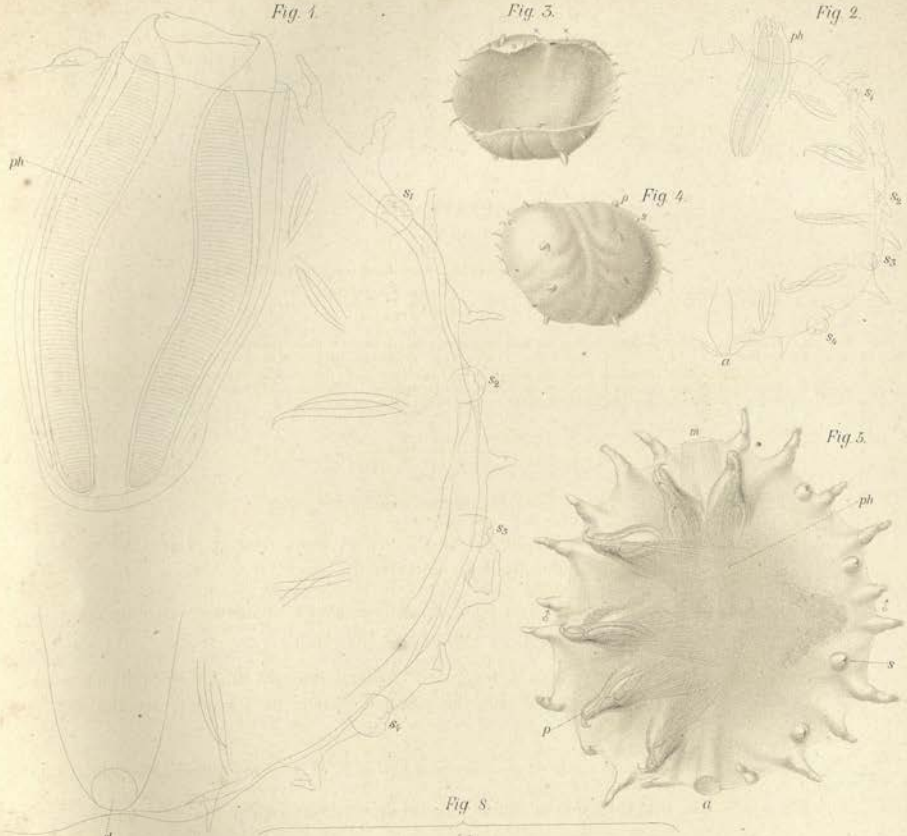


Fig. 1.
ph
s_1
s_2
s_3
s_4
cl
Fig. 3.
Fig. 4.
p
Fig. 2.
ph
s_1
s_2
s_3
s_4
a
Fig. 5.
m
ph
t
s
p
a
Fig. 8.
A
B
C
b
a
f
Fig. 7.
A
B
Fig. 6.

PLATE XV.

PLATE XV.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–4. *Myzostoma inflator*, n. sp.

Fig. 1. Disk of *Antedon angustiradia*, P. H. C. (*a.*, anal tube; *m.*, mouth), with two cysts *A* and *B* at the base of the arm; magnified about 6 diameters.

Fig. 2. Disk of *Actinometra pulchella*, Pourt., sp., with a fixed cyst (*C*) not so much magnified.

Fig. 3. Intestinal ramification of the female from the cyst (fig. 2).

Fig. 4. Dwarf male from the cyst (fig. 2), from the ventral side; magnified 75 diameters. *r.*, rectum.

Figs. 5–13. *Myzostoma murrayi*, n. sp.

Figs. 5, 6. Stalked cyst from the disk of *Antedon angustiradia*, P. H. C., from both sides; magnified 5 diameters.

Fig. 7. Diagrammatic cross section through this cyst, to show the position of the female (♀).

Fig. 8. Cyst upon *Antedon duplex*, P. H. C., about twice enlarged. *C* the *Myzostoma* cyst.

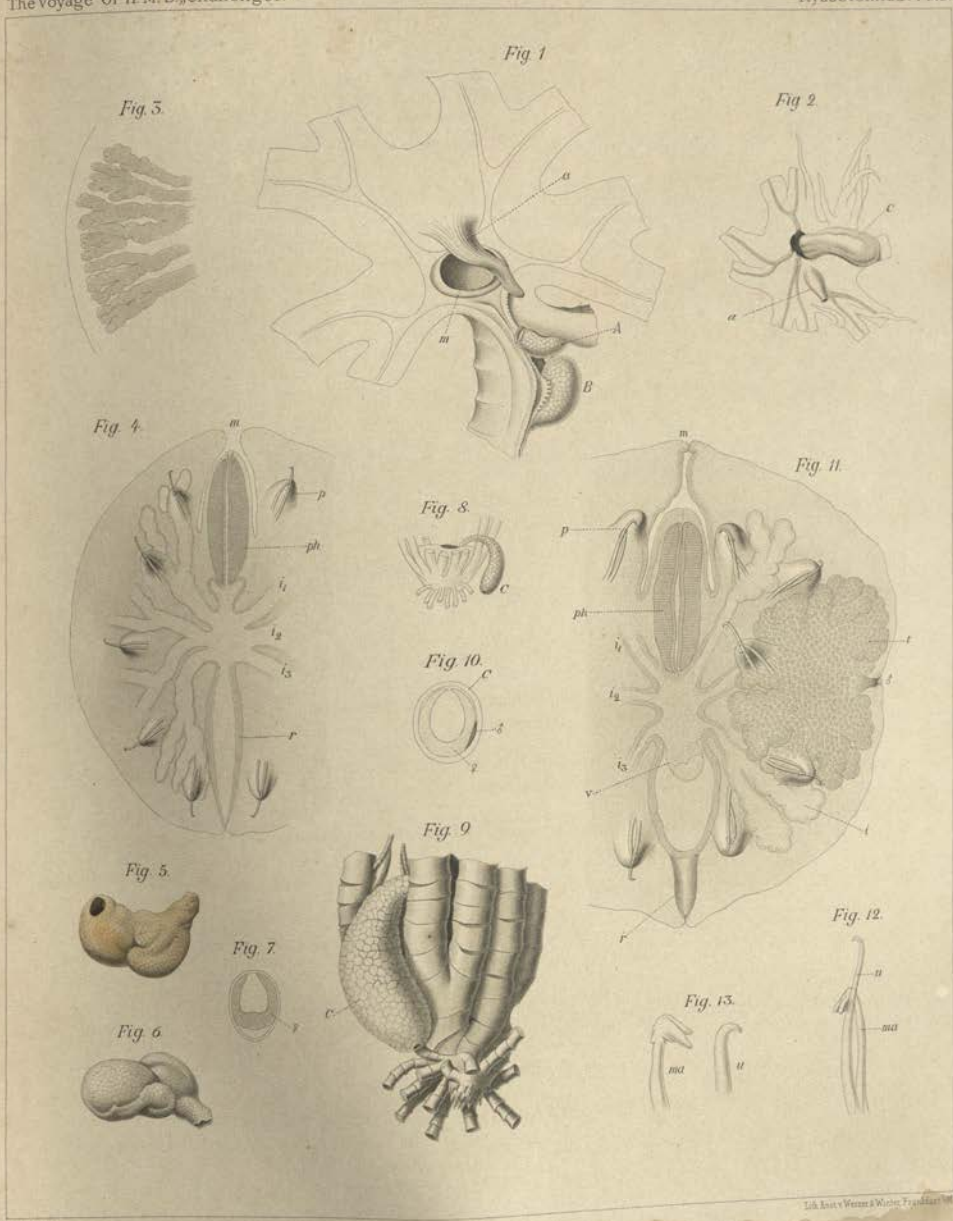
Fig. 9. Cyst (*C*) upon *Antedon radiospina*, P. H. C.; magnified about 7 diameters.

Fig. 10. Diagrammatic cross section through the latter, to show the male (♂) and the female (♀) within.

Fig. 11. The male 75 times enlarged. *v.*, valve-like circular fold between middle and terminal intestine; *r.*, rectum.

Fig. 12. A hook-apparatus slightly enlarged.

Fig. 13. The point of the hook-apparatus much enlarged.



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Lindorff Inc.

1-4. Myzostoma inflator. 5-13. M. murrayi.

PLATE XVI.

PLATE XVI.

In all the Plates the following letters have the same signification.

c. Marginal cirrus.	*p.* Parapodium.
cl. Cloacal papilla or opening.	*ph.* Pharynx.
i. Intestine.	*s.* Sucker.
m. Mouth.	*t.* Testicle.
ma. Manubrium of the supporting stalk of the hook-apparatus.	*u.* Hook of the hook-apparatus.
ov. Ovarium.	♂ Male genital papilla or opening.

Note.—The coloured drawings show the object seven times magnified; the uncoloured drawings are drawn with the Oberhäuser camera and objective 0 (Seibert and Krafft), which magnifies 40 diameters, the hook-apparatus with camera and objective IV., which magnifies 220 diameters, if the contrary be not expressly stated.

Figs. 1–7. *Stelechopus hyocrini*, n. gen. and n. sp.

Fig. 1. Combined from several sketches (camera, objective 0). *CA*, caudal appendage; *mm.*, parallel muscular bundles passing from the integument to the intestine.

Fig. 2. Fore part of the body, the mouth retracted, seen from the ventral side (camera, objective 0).

Fig. 3. Extended fore-end of another individual.

Fig. 4. Hind-end of the smallest individual, with the last two pairs of parapodia, and the caudal appendage (*CA*) (camera, objective 0).

Fig. 5. Profile view of the back, with its skin divided by longitudinal and cross furrows into flat papillæ.

Fig. 6. A parapodium with its muscle mass much enlarged (camera, objective 0). *cu.*, cuticule; *m.*, m_1., m_2., muscles of the hook-apparatus.

Fig. 7. A ripe egg (camera, objective IV.).

Fig. 1.

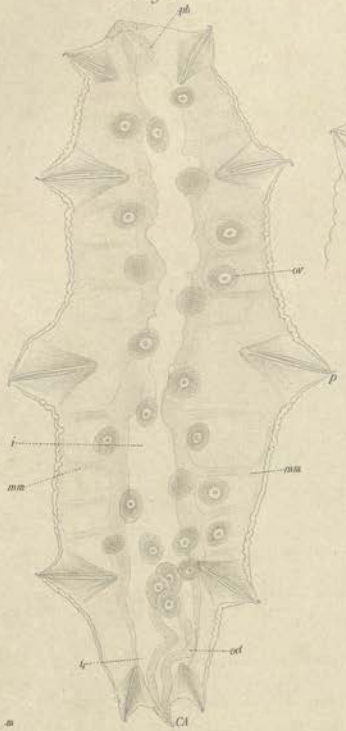


Fig. 2.

Fig. 3.

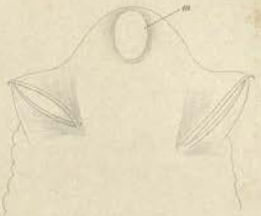


Fig. 4.

Fig. 5.

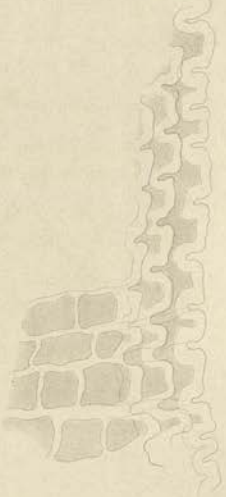


Fig. 6.

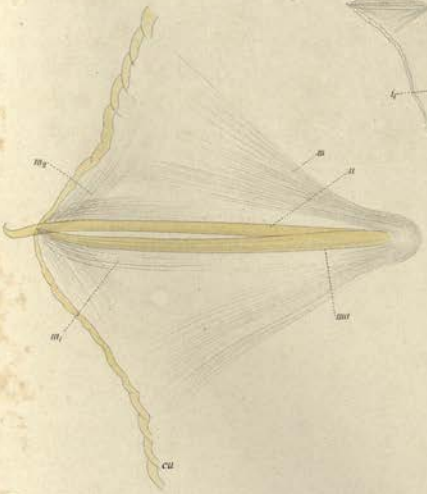


Fig. 7.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the CIRRIPEDIA collected by H.M.S. Challenger during the years 1873–76. By Dr. P. P. C. HOEK, Member of the Royal Academy of Science of the Netherlands.

ANATOMICAL PART.

INTRODUCTION.

ONE of my principal reasons for wishing to investigate the Cirripedia dredged during the cruise of H.M.S. Challenger was the hope that I should be able by the aid of the deep-sea material to enlarge our knowledge of the morphology of the order. It was possible that among the forms from considerable depths there might be some which on account of their great size, or for other reasons, would be especially favourable for anatomical research, as was the case with some of the Pycnogonids from the abysses. It was possible also that among them a new form might occur, the investigation of which would cast light on details in the organisation which had not hitherto been sufficiently understood. In this respect, however, the study of the deep-sea material has somewhat disappointed my expectations; the new forms for the most part are represented by single specimens only, or are too small to be dissected advantageously. I have therefore been obliged to limit my researches entirely to such forms as were previously known and had served for the researches of former investigators. They belong to the genera *Lepas*, *Conchoderma*, and *Scalpellum* of the pedunculated Cirripedia, and to the genus *Balanus* of the sessile Cirripedia. What I have been able to work out does not form a connected whole, but may conveniently take the form of separate chapters in the morphology of the group.

I. THE COMPLEMENTAL MALES OF SCALPELLUM.

Since 1851, when Darwin issued the first volume of his Monograph on the Sub-class Cirripedia, nothing has been published on the so-called complemental males of *Scalpellum*, though the subject was far from exhausted by his treatment of it. The truth of this assertion in no way diminishes the respect which we feel to be due to the labours of the great master in this department of investigation as well as in so many others. For when we consider that the methods of microscopic research have been greatly improved in the thirty years which have since elapsed, and that the male of *Scalpellum vulgare*, which Darwin investigated, has a size of only 0·7 mm., we can only wonder at the thoroughness of the information which he has given, and at the soundness of the conclusions at which he arrived.

When dissecting *Scalpellum vulgare*, Leach, Darwin observed one or more very minute parasites on the margins of both scuta, close to the umbones. He dissected one or two specimens and at first concluded that they belonged to some new class or order amongst the Articulata. By repeated and more careful dissection he was able to make out the general appearance of the animal, the form of the thorax and abdomen, the generative system, the antennæ and the mode of its attachment; he found that the prehensile antennæ of the little parasite showed an absolute correspondence with the same organs of the hermaphrodite *Scalpellum vulgare*, and that it belonged exclusively to the male sex. From this knowledge, together with its fixed condition and its short existence, he thought himself justified in provisionally considering the little parasite as the complemental male of the Cirriped to which it was attached.

The results of Darwin's investigation of the complemental males of the other species of *Scalpellum* known to him are, shortly, the following:—The complemental male of *Scalpellum ornatum*, Gray, sp., shows a close general resemblance to that of *Scalpellum vulgare;* but as Darwin had only dried specimens of that species, his description is not so exhaustive; he found males of *Scalpellum rutilum*, Darwin, also, but in so extremely decayed a condition that they could not be examined. What Darwin considered to be the complemental male of *Scalpellum rostratum*, Darwin, is a little animal constructed like an ordinary Cirriped and furnished with a mouth, thorax, and cirri, enclosed in a capitulum (with a carina and a pair of scuta), and supported on a peduncle of moderate size. Specimens were found attached to the integument of the hermaphrodite in a central line between the labrum and the adductor scutorum muscle. The complemental male of *Scalpellum peronii*, Gray, sp., is a pedunculated Cirriped with a capitulum of six valves, firmly cemented to the integument of the hermaphrodite in a fold between the scuta, in the middle line a little below the adductor scutorum muscle. Finally, the complemental male of *Scalpellum villosum*, Leach, sp., is attached in the same position as that of *Scalpellum peronii;* it is also six-valved, and it has a close general

resemblance to that of *Scalpellum peronii*. Whereas the parasites in the first three species (*Scalpellum vulgare*, *Scalpellum ornatum*, and *Scalpellum rutilum*) are in such an extraordinarily modified and embryonic condition, that they can hardly be compared with other Cirripeds, those of the other three (*Scalpellum peronii*, *Scalpellum rostratum*, and *Scalpellum villosum*) are pedunculated Cirripedia, remarkable for their smallness.

These are the facts which were known to Darwin; he then enters into a masterly discussion of the evidence that these parasites are really the males of the Cirripedia to which they are attached. Curious and novel as was the fact, his reasoning was so convincing that this theory has been generally accepted.

With respect to the occurrence and the structure of these complemental males, I believe I have been enabled to augment our knowledge not inconsiderably. Though the principal result of my investigations has been to convince me of the exactness of Darwin's theory, I think the question is important enough to justify me in giving all the information which I possess in the following pages.

I observed the complemental male in nineteen out of the forty-one new species of *Scalpellum* described in my Report.[1] I found them all in or about the same place, viz., at or near the occludent margin of the scutum at the interior side of this valve, a little above the adductor muscle. As a rule they are placed in a pouch formed by the mantle; very often, but not always, I found them on the left as well as on the right hand scutum. In five different species I took either from one or from both scuta two or more specimens, in the other species each, or one only, of the two scuta was furnished with a single male. In one species (*Scalpellum marginatum*) the male was seated at a considerable distance from the occludent margin of the scutum, and hence it happened that at first I did not find it out. In one species (*Scalpellum recurvirostrum*) the only male observed was still in the Cypris-larval or pupa stage; in three other species (*Scalpellum regium*, *Scalpellum eximium*, and *Scalpellum velutinum*) males in the pupa stage were attached along with full-grown males. The male of *Scalpellum brevecarinatum* could not be studied, being in a very unsatisfactory condition.

In eighteen out of the nineteen cases I was able to form an opinion as to the condition of the male when the testis was ripe, and the little creature therefore full-grown or nearly so. In five of these eighteen cases the condition can be said to correspond with that of the male of *Scalpellum vulgare*. In thirteen the males are still more degenerate. These five are *Scalpellum tritonis*, *Scalpellum intermedium*, *Scalpellum parallelogramma*, *Scalpellum elongatum*, and *Scalpellum triangulare*. I think they correspond with *Scalpellum vulgare* in as far as there are rudimentary valves visible in them. The thirteen remaining species all, no doubt, belong as regards the structure of their males

[1] Zool. Chall. Exp., part xxv. The small species represented by single specimens have not been investigated so thoroughly as would have been necessary to make out whether a male really occurred or not. I often found myself unable to do so without spoiling the specimen.

to one and the same division of the genus. I have been able to study the male of one of these (*Scalpellum regium* [Wyv. Thoms.], Hoek) more in detail; in all essential respects the males of the other twelve agree with it.

The twenty-four species of *Scalpellum*, the males of which are known at present, may be classified with regard to the structure of these males in the following way :—

A. Species, the males of which show a distinct capitulum and peduncle :—

Scalpellum peronii, Gray, sp. *Scalpellum rostratum*, Darwin.
Scalpellum villosum, Leach, sp.

All these are shallow water species.

B. Species, the males of which do not show a division of the body into a capitulum and a peduncle, but yet are furnished with rudimentary valves :—

Scalpellum vulgare, Leach.
rutilum, Darwin.
ornatum, Gray, sp.
intermedium, Hoek.
Scalpellum parallelogramma, Hoek.
elongatum, Hoek.
tritonis, Hoek.
triangulare, Hoek.

Species occurring in depths varying between shallow water and 700 fathoms.

C. Species, the males of which do not show a division of the body into a capitulum and a peduncle, and are not furnished with rudimentary valves :—

Scalpellum marginatum, Hoek.
strömii, Sars.
compressum, Hoek.
nymphocola, Hoek.
velutinum, Hoek.
eximium, Hoek.
Scalpellum gigas, Hoek.
regium (Wyv. Thoms.), Hoek.
darwinii, Hoek.
tenue, Hoek.
dubium, Hoek.
flavum, Hoek.
Scalpellum pedunculatum, Hoek.

With the exception of three (*Scalpellum pedunculatum*, *Scalpellum strömii*, and *Scalpellum nymphocola*), these species occur in depths of upwards of 1000 fathoms. The depths at which *Scalpellum strömii* and *Scalpellum nymphocola* were collected are less considerable; these species, however, belong to the arctic fauna, which, as is well known, shows numerous instances of deep-sea animals occurring in rather shallow water. *Scalpellum pedunculatum* was taken from a depth of 150 fathoms only.

a. Description and Comparison of Cypris-Larvæ.

At first I experienced great difficulties in identifying the parts of the body of the complemental male; however, I believe I have solved the problem by comparing the full-grown male with a younger stage of its development, and the latter with the corresponding stage of an ordinary species of *Lepas*. The occurrence of a Cypris-larva between the two complemental males at the ordinary place enabled me to make this comparison; from its structure as well as from the place whence it was taken there can be no doubt, I believe, that this latter creature was destined to develop (retrogressively of course) into a complemental male.

The species of *Lepas*, the Cypris-larvæ of which have served me for comparison, was the *Lepas australis*, Darwin. It is not only very characteristic on account of its great size, but it is also the best known Cypris-larva, as it served first for the investigations of Darwin, and again some years ago for the studies of Claus. The latter has given a very good figure of the internal structure of this larva as seen in a sagittal section. My figs. 1 and 2 on Pl. II. very closely correspond to that of Claus. My fig. 1 was drawn from a preparation made by dividing the body of the Cypris-larva of *Lepas australis* into two nearly equal halves by means of a sagittal section. The rounded spot (*A M*) is the adductor muscle of the two valves of the Cypris-larva; the straight line at the under side of the valve represents the ventral side, the convex one the dorsal side; the extremity on the left of my figure the frontal (cephalic), the one facing it the hinder (abdominal) extremity of the body; from the way in which the spines of the legs are stretched out at the ventral side it is clear that there is a slit-like opening between the adductor muscle and the hinder extremity of the body. In fig. 2 of Pl. I., representing a longitudinal section parallel to and at a little distance from the ventral margin, this orifice is also distinct. This is the only place where the interior of the sack or mantle (as Darwin calls it) is in open communication with the surrounding water.

The body of the future *Lepas* is enclosed within the sack and has also a wall of its own; on one side (the right hand side of the figure) this wall is very distinct, and it passes over near the middle of the dorsal margin into a transverse invagination which almost reaches up to the ventral side. It is by this invagination that the division of the body into a capitulum and a peduncle is brought about; what in fig. 1 of Pl. II. is placed on the right hand side of the invagination (*Inv.*) is the capitulum, what is placed on the left hand side the peduncle. As the invagination of the dorsal wall does not reach as far as the ventral side, a direct communication remains between the capitulum and the peduncle. Through this commissure, which is very narrow in the full-grown animal, pass the oviducts and the nerves destined for the peduncle.

On the ventral side an invagination is seen at a distance of about one-fourth of the total length from the peduncular extremity; at the bottom of this invagination, when

studied in a sagittal section as figured, the compound eyes—which, according to Darwin, are attached to the basal joints of the antennæ—are visible.

The structure of the interior of the body can easily be made out by the aid of the figure. *M.* is the mouth; it is surrounded by darkly pigmented parts, the exact shape of which is not very distinct; the mouth gives entrance to the œsophagus (*Œ*); the latter has a horizontal direction, is furnished with a pair of cœca (*C*), and leads into a very capacious stomach (*S*), from which a narrow intestine (*Int.*) is seen to start. Œsophagus, cœca, stomach, and intestine are all very darkly pigmented. The six pairs of cirri and the caudal appendages present nothing particularly interesting; the different cirri have only to shed their skin to change into the cirri of the *Lepas*; the caudal appendages will have to undergo a very marked retrogressive metamorphosis to change into the rudimentary, uniarticulate, and smooth appendages of the full-grown *Lepas australis*. The nervous system is already quite distinctly visible; it consists of the supraœsophageal ganglion (*GS*), and the six thoracic ganglia (*G I.–G VI.*). The first is situated very close to the cœca of the œsophagus and has a simple eye (*e*), represented by a small triangular spot of pigment attached to it (fig. 2, *e*). The chain of thoracic ganglia is on the right hand side of the stomach, between this organ and the ventral wall of what is properly the body. The ganglia are not yet separated by commissures, but are placed close to one another; the first has an oval shape, and is much larger than the following ones The ganglionic cells which cover the surface of the different ganglia are extremely small.

In the peduncular part of the body nearly all the room is filled up by a mass of connective tissue with very large meshes; between this mass of reticular connective tissue and the layer of cells which represents the mantle a double layer of muscular fibres may be discerned. The fibres of the two layers are at right angles to each other, and both layers run parallel to the surface of the body and the valves of the Cypris; in the figure, one of these layers is represented by the lines running parallel to each other, and also to the curved frontal line of the larva. This layer is composed of rather broad fibres (each fibre has an oval, not very elongate nucleus) and a breadth of 0·012 mm., which will develop into the layer of longitudinal muscles of the peduncle of the *Lepas*. The other layer is situated between the former and the mantle, and shows much narrower fibres, with very narrow and elongate nuclei (each fibre has a breadth of only 0·003 mm.); this latter layer forms the circular muscular layer of the peduncle in the full-grown *Lepas*. The cells which constitute the mantle are relatively small, and are furnished with large nuclei (0·01 mm.); at different places they are richly pigmented.

Between the fibres and nuclei of the connective tissue numerous fatty bodies are visible which are more like vesicles than grains; they have an elongate shape, are pointed at both extremities, and belong to what still remains of the yolk.

The cell-masses which Claus[1] describes as the cement-glands were very strongly

[1] Claus, C., Untersuchungen zur Erforschung der genealogischen Grundlage, &c., Wien, 1876, p. 87.

developed in the larvæ of *Lepas australis* which I studied. Claus says that these glands consist of groups of cells which have either still the form of a sinuous string ("eines gewundenen Stranges"), or which lie scattered by the side of one another; the latter is the case in *Lepas australis*. Claus has not observed the communication of these glands with the cement-duct which he figures; at least in his figure they are at a very considerable distance from one another. I have not been more fortunate; I even failed to observe the cement-duct. The different cells (Pl. II. fig. 5) do not show much resemblance to the cement-glands of the full-grown animal; yet I think that Claus' supposition as to the nature of these elements is right. As regards the place they occupy in the Cypris-larva, it quite corresponds to the place they occupy in the full-grown animal, viz., in the most posterior (when the animal changes its position, the most superior) part of the peduncle. The Cypris-larva which furnished the drawing fig. 2 is a little older than the one figured in fig. 1. In the former the cement-cells are much more separated from one another than in the latter; moreover, their nuclei are much more easily distinguishable, and many of them are not so richly furnished with fatty granules as was the case in the younger condition. Very delicate and flat fibres in the later Cypris-stage are visible between the cement-cells; probably they represent the canals figured by Claus and considered by him as branches of the cement-ducts.

A pair of club-shaped bodies is situated near the ventral wall of the animal, the thickest part of which is directed towards the front of the Cypris and the narrower part of which can be traced as far as under the cœca of the œsophagus of this larva. These are described by Claus as the ovarium (figs. 1 and 2, *Od*). I observed these bodies also, and I think it very probable that they represent the female genital apparatus; they are especially distinct in the longitudinal section of the body shown in fig. 2. In this figure the valves of the Cypris are not represented; the clear margin round the body represents the chitinous wall of the future *Lepas;* the cells of the mantle serve as a matrix for its formation.

When we look now at the figure of the Cypris-larva of *Scalpellum regium* which is destined to develop into a complemental male, we observe great analogy as well as considerable difference. Pl. II. fig. 3 represents a larva which has probably attached itself lately, and which therefore is exactly in the same stage as the larva of *Lepas australis* which I have just described. It is somewhat different from the latter in general outline, being more elongate and not so high. At the hinder extremity the Cypris of *Lepas australis* is obliquely truncated and bluntly pointed, and that of the male of *Scalpellum* almost entirely transversely truncated. Like the former it is enclosed within a shell consisting of two valves of a very brittle constitution. The antennæ (*An*) are stretched forward out of the ventral slit between the two valves; they have in all essential respects the same structure as those of the full-grown complemental male, which will be described further on. At their base in the interior of the body of the larva a cellular

body is visible which, I think, must necessarily represent the cement-gland. However, neither the place it occupies nor its structure shows any resemblance to the same glands—or what we must consider as such—in the Cypris of *Lepas australis*. Nor have these glands in the male of *Scalpellum regium* great conformity with those organs in the younger Cypris-stage of another species of *Scalpellum* (*Scalpellum triangulare*), which I figure in Pl. II. fig. 4. In this stage the antennæ (*An*) are still totally hidden within the valves, and the cement-glands (*C. gl*) form very large cellular masses situated on both sides of the thoracic part of the body between it and the valves. I think it is in this stage that the Cypris-larva leaves the mantle cavity of the mother.

What we called the mantle in the Cypris of *Lepas australis* takes in the male Cypris of *Scalpellum regium* the form of a bag closed on all sides, with only a very small opening at the hinder extremity. This opening no doubt corresponds to the slit-like opening at the ventral side of the Cypris of *Lepas*. It also serves the same purpose. We see the very delicate and slender spines placed at the extremity of the legs come forth from this opening. For want of material I have not been able to study in detail the structure of the mantle, nor its musculature. I can only say that the mantle is composed of flat and pale rounded cells of 0·01 mm. in diameter, with a small clear nucleus, and that these cells are placed at a little distance from each other; that the muscular fibres form a single layer only, and are built up of elongate oval cells placed in longitudinal rows and each furnished with a distinct nucleus (Pl. I. fig. 7). Besides the body the interior of the mantle contains a mass of connective tissue with little grains and small fatty corpuscles scattered irregularly throughout its meshes. With regard to the body it is not difficult to observe the mouth (Pl. II. fig. 3, *M*), the œsophagus (*Œ*), and the stomach (*St*); the nervous system consisting of a supraœsophageal ganglion (*G S*) and a single, rather large thoracic ganglion (*G T*); six pairs of very slender cirri with delicate spines at their extremities; a pair of long and well developed caudal appendages (*C A*). A dark coloured mass, consisting for the most part of yolk-fragments, makes up a great deal of the rest of the true body of the embryo *Scalpellum*.

As for details, I can only say that the parts which surround the mouth are not very distinct, and that the very long œsophagus leads into a blind pouch of an oval shape, and that this pouch represents the stomach. The two branches of each cirrus are indistinctly divided into four segments; the shape of each segment is cylindrical, with the exception of the last joint, which is conical, and slopes into the very long spines placed at the extremity. The first two pairs of cirri are somewhat different from the following pairs, inasmuch as in the first two the lower two segments are the only ones which are filled up with a mass of cellular structure; so, when the cirri have shed the exuviæ which now cover them, the cirri of the first two pairs undergo a considerable diminution in length. The very long caudal appendages in this stage are also represented only by the chitinous skin. After the last casting of skin they will no doubt have disappeared.

The supracœsophageal ganglion is well-developed; in one of the specimens two nerves were indistinctly visible starting from the ganglion and directed towards the antennæ; if my observation be correct there can be little doubt that these are the antennal nerves. I have not observed the commissures which unite the supracœsophageal ganglion with the thoracic ganglion; the latter is large and oval, and probably only represents the first larger ganglion of the thoracic chain of *Lepas*. Neither the small eye near the supracœsophageal ganglion nor the large compound eyes at the base of the antennæ are present; the pigment which is so richly distributed over all the organs and parts of *Lepas australis* is totally wanting in the male Cypris of *Scalpellum*. This no doubt finds its explanation in the circumstances under which the little animal is destined to live.

Of great importance is the fact that the dorsal invagination, which, as we have seen, causes the division of the body of *Lepas* into a capitulum and a peduncle, is totally lost in the metamorphosis of the Cypris of the male of *Scalpellum;* hence there is no trace of this division to be observed in the full-grown males. This want of a peduncle, together with the smallness of the orifice of the mantle and the total absence of valves, form the most characteristic features of the male in question.

The metamorphosis of the Cypris-larva, in its latest stage (as figured), into the full-grown male, is now, I think, easy to understand. In this respect at least it quite corresponds to the metamorphosis of *Lepas*. The difference between the latest stage of the Cypris of *Lepas australis* and the young Cirriped of that species is not greater, nor less either, I think, than that between the attached Cypris of *Scalpellum regium* and the young male; to say that the complemental male of *Scalpellum* is in its Cypris stage, or thereabouts, is not in accordance with the facts.

The valves of the Cypris are first of all shed. The cells of the mantle or sack soon develop a distinct membrane of chitin at their surface, which no doubt is as efficient a protection as the shell was, but which contains no carbonate of lime and therefore is not so brittle. When the wall of the male is quite intact, its impenetrability makes it absolutely unfit for transference from absolute alcohol into oil of cloves; the alcohol leaves the little body faster than the oil enters it, whence the body-wall becomes shrivelled. As the internal structure is best studied in a specimen placed in oil of cloves, and as for its investigation by transverse sections the passing through oil of cloves was also necessary, I found it very useful, when the specimens were quite sound, to make a little opening in the wall before transferring them into the oil. For the rest, this internal structure is very simple. The antennæ and the very delicate thorax with the legs are the only parts which show that the little body belongs to an articulate animal; the whole interior of the body is filled with a mass of connective tissue with very wide meshes, serving to keep the different organs in their places.

b. Anatomy of the Male of *Scalpellum regium.*

I will now proceed to give an anatomical description of the complemental male of *Scalpellum regium* (Wyv. Thoms.), Hoek. I choose this species because it is represented by numerous specimens, and also because it is one of the largest species in the Challenger Collection.

Form and dimensions.—The complemental male of *Scalpellum regium* has an elongated oval shape. Its length varies from 1·6 to 2·4 mm., its breadth is 0·63 to 0·71 mm. The difference in length corresponds to differences in some of the internal parts, especially of the testis. Whether it is occasioned by the growth of this organ I cannot say. The third dimension, the thickness, is nearly equal to the breadth. We may call the extremities of the longer axis the poles of the body, and I propose to call one the peduncular, the other the capitular pole (Pl. I. fig. 1).

The Antennæ.—The only appendages visible externally are the small antennæ, situated close to the extremity of the body corresponding to the peduncle of other Cirripedia; they are seated at a little distance from the extremity, on that side of the body which represents the ventral surface. They have two segments; one cylindrical, and about twice as long as the other, which is flat and triangular. What Darwin calls the third and ultimate segment of the antennæ is very distinct in the case of this little creature (Pl. I. fig. 3). It is articulated to the upper surface of the disk, and directed rectangularly outwards. Whereas the main segments of the antennæ are not furnished with spines, this latter segment bears five spines at the end, and three very slender ones at a notch a little beneath the extremity of this segment.

With the aid of these antennæ the little creatures are attached to the inner surface of the scutum of the hermaphrodite or female. The triangular terminal segment of the antennæ, in all the cases I observed, surrounded the extremity of a transparent mass, which I think can safely be considered as the product of the cement-glands which are in relation with the antennæ. It is by means of this cement that the attachment of the triangular disk takes place. In the case of *Scalpellum regium* the males are attached a little above the adductor muscle, and, as a rule, three of them are implanted so closely together as to touch each other. What I think very peculiar is, that in three different cases observed by me, two of the three males attached to the scutum were much further developed than the third; the first contained a fully developed testis and a well-filled vesicula seminalis, the third was still in the condition of a Cypris-larva (Pl. II. fig. 3), probably only lately attached to undergo its final metamorphosis.

The wall of the body is a chitinous skin, which is comparatively thin and delicate; when a transverse section of the body is made, the chitinogenous epithelium beneath the

chitinous outer wall is easily observed. The external surface of the body-wall is clothed with microscopic spines, having a length of about 0·0235 mm., and placed in transverse rows (not quite so regularly as shown in fig. 1 of Pl. I.). As a rule, these spines are narrow and pointed at the extremity, which is attached to the wall of the body and broadest at the other extremity. Here the free margin is deeply toothed, which gives the spines a certain resemblance to the scales of the Lepidoptera. In other places the incisions of the spines are so deep as to divide the scale into two or three narrow spines. A small circular space at the peduncular pole is left free from spines, and at the other extremity the terminal part is so completely covered with minute particles of mud and sand, that it is impossible to distinguish the little spines there. This latter part of the body is the only one which is visible when the little male is in its ordinary place, viz., between the mantle or "sack" (as Darwin calls it) and the scutum of the hermaphrodite. A small rounded part at the capitular extremity of the body is covered by a chitinous membrane of greater thinness. The nuclei of the chitinogenous epithelium are placed here much more closely and are more easily visible owing to the thinness of the chitinous wall. A narrow slit-like opening (fig. 1, *o*) divides this little circular space; it corresponds with the orifice of the capitulum of the pedunculated Cirripedia. It is not easy to distinguish the edges of this slit-like opening, owing, as Darwin suggested for the same orifice of *Scalpellum vulgare*, to their extreme thinness.

The chitinogenous membrane which is found beneath the chitinous outer wall shows the ordinary structure of very flat cells with indistinct limits and with rather distant but conspicuous nuclei. These nuclei are very close to one another at the small circular part at the capitular extremity (Pl. III. figs. 2 and 3). The slit which indistinctly divides this part gives entrance to a cavity which contains the thoracic part of the little male. This cavity is not lined by an epithelium; it is only surrounded by a somewhat more solid layer of the same connective tissue, which fills up the whole interior of the body of the male. This cavity is seen in transverse section in Pl. III. fig. 4. In all the specimens of this species which I investigated the thoracic part was always retracted high up into the interior of the body, so that even the very long spines at the end of the slender limbs never reached the slit-like orifice at the capitular pole. In the males of some of the other species (*Scalpellum intermedium*, *Scalpellum tritonis*) the spines at the end of the thoracic limbs extend beyond this orifice. This was often also the case in the males of *Scalpellum vulgare* as observed by Darwin, which always showed the whole thorax forced outwards through the orifice, a circumstance which perhaps was owing, according to Darwin, to the action of the spirits of wine and consequent endosmose.

Muscles of the body-wall.—Under the cells of the hypodermis a well-developed layer of muscular fibres is everywhere present; these muscular fibres are indistinctly transversely striated; in some of my preparations, however, the transverse striation is some-

what more distinct. Perhaps the indistinctly striated condition of the fibres is the consequence of their being nearly functionless and rudimentary.[1]

From their position close to the body-wall one feels inclined to compare these muscles together with the outer wall of the body with the "Hautmuskelschlauch" of worms, as the Germans call it. The muscular fibres form a single layer only; they have an irregular oblique direction, which in some parts approaches to a transverse, in other parts to a longitudinal, position; their course is imperfectly parallel. Their structure is very simple, and can be best studied in Canada balsam preparations; when seen in oil of cloves their transverse striation is so indistinct as to be hardly visible. It is from such a preparation that the fig. 6, Pl. IV. has been made. When making a preparation of them by means of needles they present themselves like flat bundles of delicate fibrillæ, each bundle having a breadth of about 0·01 mm.; they sometimes show a clear wall as a kind of sheath, and are furnished with nuclei at intervals; the latter are elongate, and, as appears on a transverse section of the muscle, cylindrical; they have a length of about 0·02 mm. and a transverse diameter of about 0·005. In a transverse section of the wall of the body, as in all the figures of Pl. III., the nuclei of the matrix are seen between the chitinous outer wall and the transverse sections of the muscles. In these sections the latter show a very curious structure (Pl. IV. fig. 5); whereas that side of the muscle-fibre which is directed towards the anterior of the animal is smooth and arched, and shows the sheath in the form of a distinct margin; that side of the same fibre which is directed towards the exterior is deeply toothed; here the fibrillæ which compose the fibre seem to part in different ways. As I could observe this phenomenon only in very thin sections, there can be no doubt that this structure does not agree with the natural condition of the fibre. The nucleus of the muscle-fibre is sometimes placed near the outer wall, sometimes almost in the centre of the fibre. As to the development of the muscle-fibre, when comparing it with the condition of the muscular fibre in the Cypris-larva, we may suppose that the oval contractile cells which compose the larval fibre grow out into long fibres, the pointed extremities of which are no longer placed in a longitudinal row, but have been pushed along each other.

The connective tissue is composed of fibres, but also of extremely delicate and finely granulated membranous plates which form the partitions between the large meshes. Its nuclei are round and flat, and have a diameter of 0·008 mm. The fibres are more robust where they form the wall of the cavity in which the thorax is situated; we find also stronger fibres where they run in a straight direction from the organs to the wall of the little animal.

I have not observed a true body-cavity in these little males, and before I had studied the bodies of other Cirripedia by means of transverse sections, I was much

[1] Leydig (Zum feineren Bau der Arthropoden, *Arch. für Anat. und Physiol.*, 1855, p. 394) says that the muscle-fibres of young individuals of *Coccus hesperidum* are distinctly transversely striated, those of full-grown individuals which almost lost the function of locomotion are totally rudimentary (and smooth ?).

puzzled by this fact. A part of the body of this male corresponds to the peduncle of the pedunculated Cirripedia, and as this is also filled up with connective tissue,—with the exception of a rather narrow tubular cavity towards the rostral side,—I at first endeavoured to homologize the connective tissue of the male with that of the peduncle. Extending my researches also over the body of the hermaphrodite or female *Scalpellum*, over *Lepas* and other genera of Cirripedia, I found that the occurrence of a well-developed mass of connective tissue between the different organs within the body is the rule in all the Cirripedia. In the interesting essay on the cœlom-theory by the brothers Hertwig [1] we read that all the Arthropoda possess a very capacious body-cavity, and that in the full-grown animal the intestinal tract passes freely through this cavity, a dorsal mesentery uniting the intestine to the wall of the body being observed only in a younger stage of the development. Whether the plurality of typical forms of Arthropoda have been sufficiently investigated so as to allow of this conclusion to be drawn, I will not decide. Doubtless, however, the Cirripedia have a very rudimentary body-cavity, and a well-developed mass of connective tissue nearly fills up all the space left open between the wall of the body and the internal organs. So the complemental males in this respect also correspond in structure to the female and hermaphrodite animals.

The internal organs consist of the well-developed genital apparatus, the nervous system, the cement-glands, and the totally rudimentary and evidently functionless œsophagus and stomach.

Fig. 1 of Pl. I. shows these parts in their normal position; fig. 2 represents part of these organs more strongly magnified. Testis (*t*), vesicula seminalis (*vs*), and vas deferens (*vd*), can easily be made out in all the specimens. Neither do the other organs (the nervous system, and the œsophagus with the stomach), present any further difficulties after comparison with the structure of the Cypris-larva (Pl. II. fig. 3).

Digestive tract.—The œsophagus and the stomach have nearly preserved their original condition; the mouth has grown totally functionless; its place is indicated by the presence of a group of cells (Pl. I. fig. 2 *m*), which are placed in the connective tissue bordering the cavity in which the thorax is situated. The œsophagus is a narrow tube which imperceptibly widens and passes over into the stomach. The latter is a pyriform pouch closed on all sides, having a rudimentary intestine at the extremity opposite to the cardia. It has a double wall, as can be best studied in the transverse sections (Pl. III. figs. 6 and 7). Probably the internal wall represents a chitinous cuticle which has been shed, but which could not be removed, the mouth being closed. Perhaps the internal wall represents the chitinous tube, or model of the stomach filled with excrement, Darwin describes in the alimentary canal of Cirripedia.[2] In the full-grown male the stomach is almost empty; in a younger condition (Pl. IV. fig. 1), the stomach is filled

[1] O. and R. Hertwig, Die Coelomtheorie, *Jenaische Zeitschr.*, Bd. xv, p. 76, 1882.

[2] Darwin, Balanidæ, p. 86, 1854.

with a yellowish-brown coloured mass of a fatty nature. Between the two walls of the stomach, nuclei of nearly the same size as those of the connective tissue are visible.

Nervous System.—The supraœsophageal ganglion, also, has nearly kept its original position; it is situated against the œsophagus, a little anteriorly to the place where it communicates with the stomach. In Pl. I. fig. 2 it is figured in its natural position and condition; in Pl. III. fig. 5, and Pl. I. fig. 4, it is seen in transverse section; numerous rounded ganglionic cells are placed at the periphery, and the whole interior of the ganglion is occupied by the medulla. Pl. I. fig. 4 distinctly shows the commissures which serve to unite the ganglion with the large thoracic ganglion. In the preparation which is figured (Pl. I. fig. 2) these commissures could not be made out, nor has this been possible in any of the other preparations I made by the aid of needles.

This thoracic ganglion represents alone the whole ventral nerve-cord; together with the thorax, it has changed its place and has been transposed in a direction towards the front of the animal, so as to be now attached before the supraœsophageal ganglion; it has an elongate oval shape with numerous ganglionic cells at the periphery. In a transverse section such as that figured (Pl. I. fig. 5), we observe that the ganglionic cells form a much thicker layer on the side which is directed towards the thorax than on the other side; the lateral symmetry of the ganglion is very distinct, the medulla forming two rounded portions which meet in a straight line in the middle of the ganglion. The nerves given off from this ganglion as well as those from the supraœsophageal ganglion are extremely delicate and are hardly recognisable as such; two somewhat stronger nerves start from the commissures very close to the supraœsophageal ganglion, and a distinct nerve is attached terminally to the thoracic ganglion, but as for other nerves, I found it impossible to distinguish them with certainty from the fibres of the connective tissue.

There are no organs of sense; even the sense of touch can be only very slightly developed, as the whole body is enclosed within a chitinous bag bearing only chitinous spines on its surface. The hairs on the antennæ (Pl. I. fig. 3) no doubt once performed the function of organs of touch, but after the antenna has attached itself the function of these hairs can no longer be of any importance. Close to the supraœsophageal ganglion I always observed two little bodies, which, from their position, I at first felt inclined to consider as belonging to the nervous system. They are kept in their places by the connective tissue, and they are situated near the corner between the stomach and the supraœsophageal ganglion. Their structure is that of an oval bag slightly pointed at one or both extremities, lined by an extremely delicate membrane and filled with a granular substance of a brownish-yellow colour, having numerous nuclei scattered throughout its interior (Pl. I. fig. 2, *gl.*). Most probably these organs represent the remains of the appendages of the œsophagus (Pl. II. figs. 1, 2, *C*) of the pedunculated Cirripedia, which are very distinctly developed in the

Cypris of *Lepas*, and which probably correspond to the salivary glands of Cuvier; that they are here as rudimentary and as functionless as the œsophagus and the stomach itself is an argument, though a negative one, in favour of my interpretation.

In some of the sections and preparations I observed globular elements which I think are blood-corpuscles. I have figured some of them (Pl. IV. fig. 7). They have very distinct dark coloured nuclei and their size varies from 0·015 to 0·02 mm.; by their size alone they can be easily distinguished from the nuclei of the connective tissue.

From the condition of the mouth and the alimentary canal there can, I believe, be no doubt that these little animals never take food at all. For this reason it is necessary not only that the whole of the body with its well-developed genital apparatus develops from the yolk-mass in the Cypris-larva, but it must be supposed also that the little body can only furnish so much of the male genital product as may develop from the testis after it has once arrived at its full size and maturity. Probably therefore each male only once, or in one season with short interspaces, takes part in the act of propagation. And as it is highly probable that the species of *Scalpellum*, like most other animals, spawn only once a year, the male which has once furnished its quantum of the male genital product is to be replaced by another. The objection may be made that it is possible that only one part of the spermatozoid mother-cells develops into spermatozoids in one season, and a second part in a following year; but then it is difficult to understand, with our present knowledge of animal life, in what way the little animal is supplied with the material necessary for its maintenance.

The Male Organs.—The testis is heart-shaped with the incision directed towards the hinder or capitular extremity. Its length in some of the specimens was about 0·5 mm., in others, which themselves were longer, no less than 0·8 mm. In the latter case the incision was more than half as long as the organ.[1] This incision is remarkable, I believe, because it is the only sign of the original duplicity of the male genital gland.

The histological structure of the testis presents no points of special interest; the spermatozoid mother-cells have a size of 0·021 mm. and fill up the whole interior of the gland. They split into extremely small transparent cells with a dark coloured little body for a nucleus. These small cells are 0·004 mm. in diameter and I think each of them develops into a spermatozoid. The wall of the testis is built up of connective tissue with nuclei of 0·01 mm. in diameter; the wall of the vesicula seminalis presents about the same structure. It is an irregularly globular vesicle, having in the full-grown and mature males a diameter of 0·3 mm.; it is very closely pressed against the testis.[2] In younger specimens I did not observe this organ; the vas deferens in them only presented a very small swelling at the place where it communicates with the testis; the

[1] The testis of *Scalpellum darwinii* when young does not show an incision; in older specimens, however, traces of an incision are present. Other species (*e.g. Scalpellum tenue*, Hoek) have the testis triangular with a heart-shaped foot.

[2] In other species (*Scalpellum tenue*, *Scalpellum darwinii*, &c.) the testis is separated from the vesicula seminalis by means of a duct of not inconsiderable length.

vesicula seminalis is no doubt only a dilatation of the vas deferens at the place where it corresponds with the testis. The vesicula seminalis in all the larger specimens was filled with a dense mass of very small spermatozoids; they have the shape of threads, each having a length of about 0·02 mm., and each furnished at the extremity with a very small vesicle (Pl. I. fig. 6). Between the spermatozoids in the vesicula seminalis small empty vesicles are seen, as also others which quite resemble the very small cells of the contents of the testis, probably each one of them contains a spermatozoid.

The length of the canal acting as a vas deferens is not very considerable; it passes freely through the connective tissue for about 0·25 mm. and then enters into that part of the body which represents the thorax of the Cirriped. Figs. 10 and 11 on Pl. III. show sections of the duct before it reaches the thorax, but in the figs. 5 to 8 of Pl. III. the same canal is represented in the middle of each transverse section of the thorax. In fig. 9 the form of the section of the thorax is nearly quadrangular; this is its shape near the place where the vas deferens enters it; in the sections, however, which more approach the other extremity of the canal the thorax is exactly cylindrical, and then its wall is parallel to the wall of the genital canal. The diameter of the thorax itself is about 0·08 mm.; the canal which runs through it longitudinally has a width of 0·03 mm. Whether it be preferable to designate the cylindrical terminal portion of the thorax as "penis" is, I think, difficult to say; morphologically it is hardly to be distinguished from the appendix of that name in the hermaphrodite Cirriped, which is called by some authors a penis, by others an abdomen.

The nuclei of the cells which surround this canal (Pl. I. fig. 5) are slightly larger than those of the connective tissue placed between the canal and the chitinous wall of the thorax; as far as I could distinguish in any of the sections, these cells of the wall of the canal have no distinct shape and do not compose a true epithelium. From the place where it enters into the thoracic part of the body the vas deferens is seen in all the sections which pass transversely through the thorax; it may be traced for about half a millimetre; it then ends abruptly; probably, though this could not be distinctly observed, it now opens into the cavity (Pl. III. fig. 4 *ca*) lined by the connective tissue, which has an outward opening at the capitular pole of the body. The communication with this cavity must be about at the height of the supraœsophageal ganglion. The whole thoracic part of the body can be stretched forward in a direction towards the capitular pole; though I do not believe that the opening of the vas deferens ever reaches the opening at the surface of the body, this stretching forward of the thorax is no doubt brought about in order to approach the opening of the vas deferens as much as possible to the slit at the extremity of the body. Well-developed musculi retractores serve for the retraction of the thorax within the body of the male. I have figured one of them on Pl. I. fig. 1, *mr*. In the transverse section figured on Pl. III. fig. 10 these muscles are also represented.

The Appendages.—As far as the number and the shape of the appendages of the thorax are concerned, it has proved rather difficult to get any certainty; in the first place, because the limbs with their thin chitinous wall refract the light in the same way as the thorax, and are pressed so closely against the body of the thorax as to make it impossible, even in a well-stained preparation, to make out their respective outlines, and in the second place, because of the smallness of the parts in question. After a careful study of sections, as well as from preparations made by dissection with needles, I believe the following facts may be safely relied upon. Only four pairs of legs are relatively well-developed; these are the four posterior pairs, and each of them is composed of two branches. Of the first two pairs of cirri only one very short branch is left. Each branch of the double-branched ones is relatively long and narrow, and terminates in two or three very long spines. In a transverse section each leg is represented by its chitinous wall and by the nuclei of its matrix, which are more or less elongate (Pl. I. fig. 5).

The Cement-Glands.—Finally, I must describe in a few words the structure of the cement-glands. They may be best studied in a section of a not quite full-grown specimen, as shown in Pl. IV. fig. 3. Each male contains a pair of these glands; they are situated a little above the vesicula seminalis (Pl. I. fig. 1 *c. gl.*); they have an oval shape, and measure about 0·15 mm. They are composed of very large cells with granular contents and a large nucleus, kept together by an extremely delicate network of connective tissue with a single rather small nucleus here and there between its fibres. Between the large cement-cells cavities are left open here and there in the connective tissue; each cell has the shape of a wedge, and is placed so that the broader part is directed towards the periphery, the narrower, on the contrary, towards the centre of the gland. The structure of the contents of each cell is rather remarkable, since the larger granules are placed at the periphery, and the contents are much more homogeneous towards the narrower extremity of the cell. In one of the preparations the ducts which run from the gland to the antennæ were rather distinct; they are attached as thread-like appendages to one of the narrower extremities of the gland.

Summary.—I think I have given herewith a full description of the so-called complemental male of a species of *Scalpellum*. With this description, and with the figures on Pls. I.–IV., it is possible not only to prove that this male has a highly degenerated organisation, but also to demonstrate in what this degeneration consists, and how it affects some of the organs very greatly, whilst others suffer less from it, and some are not influenced by it at all.

The state of things in the male under consideration may be summed up as follows:—

1. The external characteristic shape of the species with its capitulum and peduncle, its valves and scales, is lost. The microscopic body consists of an elongate bag closed on

all sides. A very small slit represents the opening between the two scuta. The antennæ are the only extremities which still show their original condition; the cirri have grown straight and functionless; the parts of the mouth have disappeared.

2. The cement apparatus is well developed as long as the male is young; when mature it is no longer so distinct.

3. The intestine has become functionless and is quite rudimentary; circulatory and respiratory organs may be passed by, as they have no distinct organs even in the hermaphrodite *Scalpellum*.

4. The nervous system consists of a relatively small supracesophageal ganglion, of a not very stout œsophageal ring, and of a large thoracic ganglion. It is probably the latter which alone regulates the functions of the genital apparatus. The peripheral part of the nervous system is not much developed. The eyes (and other organs of sense) have been lost.

5. The genital apparatus is the only well-developed system of organs. The female apparatus, however, is totally lost, and even the male organs show a great deal more concentration than do the same organs in ordinary hermaphrodite Cirripedia. In the first place the testis is single, and has become a rather compact gland, whereas in other Cirripedia it is double and scattered throughout almost the whole interior of the body. In the second place, the vesicula seminalis is also represented by a single vesicle only, hermaphrodite Cirripedia, on the contrary, having always two of them.

In all these respects the little males of other deep-sea species of *Scalpellum* which I have been able to investigate exactly correspond to the male of *Scalpellum regium*. So does the male of *Scalpellum vulgare* (from specimens from the Mediterranean) with the exception of the presence of rudimentary valves, which in that species, as in some of the deep-sea species (*vide* p. 4), represent the so-called primordial valves of the young capitulum of pedunculated Cirripedia.

c. General Observations.

In the case of *Scalpellum vulgare*, Leach, *Scalpellum rostratum*, Darwin, *Scalpellum peronii*, Gray, sp., and *Scalpellum villosum*, Leach, sp., Darwin observed what he considered a penis; in *Scalpellum vulgare*, Leach, and in *Scalpellum villosum*, Leach, sp., he ascertained, moreover, the presence of vesiculæ seminales and testis in the specimens which were also furnished with ovaria. These specimens, therefore, were hermaphrodites, and as little males were found attached to their scuta, these male specimens got the very characteristic name of "complemental" males. On the other hand, *Scalpellum ornatum*, Gray, sp., did not show a trace of a proboscidiform penis in the four specimens which Darwin examined, and he, therefore, supposes that the animals studied by him were females, although it was impossible, as the specimens were

dried, to demonstrate the absence of the vesiculæ seminales and testes. The male animals were lodged in a pouch on the under side of the scutum, and in that case should not bear the name of "complemental" males. From the state of the specimens of *Scalpellum rutilum*, Darwin, which Darwin examined, it was quite impossible to ascertain whether the individual was a hermaphrodite or a female; from the analogy of its nearest congener, *Scalpellum ornatum*, the latter, Darwin says, is the more probable.

Darwin's supposition as to the unisexuality of some species of *Scalpellum* proves to be in very striking accordance with the facts. What I at first considered to be the hermaphrodite form of *Scalpellum regium* (Wyv. Thoms.), Hoek, is not furnished with a penis, and does not show a trace either of a testis or a vesicula seminalis. To have full certainty in this respect, I divided the whole thoracic part of the body of a specimen of this species into a series of sections, and in none of them did even the smallest trace of a part of the male genital apparatus appear. The body was stained *in toto* by means of aluminium carminate, a most brilliant staining for the testis and for the spermatozoa within the vesicula seminalis when present. I then repeated the examination of *Scalpellum vulgare*, Leach; I found the animal a true hermaphrodite; it is furnished with a well-developed penis, and the vesiculæ seminales have exactly the structure of these organs in species of the genus *Lepas*. The only difference is shown in their small size. Slightly more developed testes pour out their products into the vesiculæ seminales.

The specimen of *Scalpellum regium*, of which I examined a series of sections, was a full-grown animal; it was furnished with males and there were ova in the ovigerous lamellæ. I got the same results when making a series of sections of *Scalpellum parallelogramma*, Hoek (Pl. IV. fig. 9), and *Scalpellum nymphocola*, Hoek (Pl. IV. fig. 10). So I think that we may safely draw the following conclusions:—

There are species of the genus *Scalpellum*, Leach, which show a very characteristic dimorphism. Some of these consist of large hermaphrodite and small rudimentary male specimens; others have large female and small rudimentary male forms.

However, I do not believe that these are the two most divergent cases in the sexual relations of the genus *Scalpellum*. I think there is still a third category of species in this genus, viz., those which are as true hermaphrodites as other Cirripedia, and in which no complemental males are developed. As a supposed species of this third division I will point out *Scalpellum balanoides*, Hoek. In the descriptive part of my report I have communicated the fact (p. 130) that one of the specimens contained eggs, though no complemental male was present at the place it ordinarily occupies. Though I have studied some more specimens of this species with great care, I have not once observed a male; yet they were nearly all furnished with eggs. I then studied the body of one of the specimens by the aid of transverse sections (Pl. IV. fig. 8, *a–f*); I found that the specimen was furnished with a very largely developed testis greatly surpassing the same organ in *Scalpellum vulgare*. The penis of this specimen was also of considerable

size. Suppose I had observed this same organisation in a species of another genus of Cirripedia, then I should never have thought the existence of a complemental male in that species possible, and now in the case of a species of *Scalpellum* I think I may safely infer that in this species the absence of a complemental male is not an accident, but indeed the rule! I think, therefore, that there is sufficient reason to conclude that the genus *Scalpellum* presents the three following stages of sexual differentiation :—

1st. True hermaphrodite species: all the specimens develop male genital products as well as female. Whether these species are also "autogames,"[1] *i.e.*, whether the spermatozoa of a specimen as a rule fertilize the ova of the same specimen, is a point which I do not wish to discuss at present. I will only say that in case "autofécondation"[1] should be proved in the case of other Cirripedia (which at present has not, I think, been done), we can also safely admit it in the case of these species of *Scalpellum*.

Example:—

Scalpellum balanoides, Hoek.

2nd. Large hermaphrodite specimens and small unisexual (male) ones in the same species.

A. Male specimens with a capitulum and peduncle, with a mouth and stomach.

Examples :—

Scalpellum villosum, Leach, sp. | *Scalpellum peronii*, Gray, sp.
(*Scalpellum trispinosum*, Hoek.[2])

B. Male specimens with or without rudimentary valves, without a peduncle, a mouth and stomach.

Examples :—

Scalpellum vulgare, Leach. | *Scalpellum rostratum*, Darwin.
(*Scalpellum acutum*, Hoek.[3])

[1] Robin, Ch., Article "Sexe" in Dictionn. encyclopéd. d. sci. med., Paris, 1880.

[2] The body of this species has not been investigated; so my conclusion is based only on the presence of a well-developed penis, and on the great resemblance of the species to *Scalpellum villosum*, Leach.

[3] This species has not been investigated either; the supposition as to its hermaphroditism is based only on the presence of a well-developed penis.

3rd. True unisexual species; the females are large, the males very small and (probably) short-lived.

Scalpellum ornatum, Gray.
regium (Wyv. Thoms.) Hoek.
parallelogramma, Hoek.
nymphocola, Hoek.
tritonis, Hoek.

Scalpellum vitreum, Hoek.
moluccanum, Hoek.
eximium, Hoek.
darwinii, Hoek.
carinatum, Hoek,[1] &c.

Of all the genera of Cirripedia, *Scalpellum* is no doubt the one which presents the greatest amount of variety as far as the sexual relations are concerned. In this regard it even surpasses the genus *Ibla*, Leach, of which we know, through the aid of Darwin, that it presents two instances of sexual differentiation only, viz., unisexuality in the one species and hermaphroditism with accompanying rudimentary males in the other. It is well known that the genus *Scalpellum*, by means of *Scalpellum villosum*, Leach, sp., and by means of *Scalpellum trispinosum*, Hoek, blends with the genus *Pollicipes*, Leach, and also that the latter genus is one of the oldest, if not the oldest, of the genera of Cirripedia. All the known species of *Pollicipes* are true hermaphrodites as are other Cirripedia, and, moreover, *Pollicipes* seems to be a genus which only contains shallow water species. With a little imagination it does not appear to be very difficult to trace the way in which sexual differentiation took place in the genus *Scalpellum*. Originally there were only hermaphrodite species, inhabitants of shallow water. They resembled more or less the species of the genus *Pollicipes*. In some of the species specimens attached themselves to each other[2] as well as to other objects, and they developed all into ordinary hermaphrodite specimens. In one of these species, however, young specimens attached to full-grown older ones, though developing into animals of the ordinary shape with a capitulum and a peduncle, did not acquire the size of the older specimens, and lost their female genital apparatus. In a following stage, we see that the little creatures which by their smallness are enabled to hide within the valves of the older hermaphrodite specimens, lose their valves and are reduced to a rudimentary state in all respects, except so far as the male organs are concerned. Finally, we observe in the latest stage that the original hermaphrodite specimen loses its male genital apparatus and becomes unisexual. In the latter species we have large and relatively long-lived female specimens, and small and short-lived males.

I feel sure that some serious objections may be advanced against this reasoning, and

[1] The bodies of *Scalpellum tritonis*, *Scalpellum vitreum*, *Scalpellum moluccanum*, *Scalpellum eximium*, *Scalpellum darwinii*, and *Scalpellum carinatum*, have not been investigated by means of transverse sections. Their unisexuality is based only on the total absence of a penis and on their general resemblance to the investigated unisexual species.

[2] Specimens of *Scalpellum vulgare* are attached to various horny corallines, and occasionally to the peduncles of other individuals. Darwin, Lepadidæ, p. 226, 1851.

one of these I will point out myself. Those species which are unisexual and have very small and rudimentary males, which, therefore, according to the sketch given above, are the youngest of the hypothetical course in which the different stages of sexual differentiation have developed, are at the same time those which closely resemble the species from the oldest geological strata from which species of *Scalpellum* are known. But I think this objection is weakened by admitting that the sexual differentiation in the genus *Scalpellum* was already achieved at the period from which these fossil remains date. The somewhat aberrant shape of *Scalpellum balænoides*—the species in the supposed original condition of true hermaphroditism—is also difficult to explain at first sight. We might have expected to observe the original condition (hermaphroditism without complemental males) in a species as closely resembling *Pollicipes* as possible, as, for example, in *Scalpellum villosum*, Leach, sp.; or *Scalpellum trispinosum*, Hoek.[1] The condition of the genital apparatus and the external shape of the valves (the whole capitulum), however, are two factors which need not necessarily stand in so very close a relation to each other. So it may be easily imagined that the original condition of the sexual apparatus is left in a form in which the external shape of the capitulum has been altered, and, on the other hand, there is no reason why the sexual relations of a form should not become altered without the external shape undergoing considerable changes at the same time.

When, however, all these considerations are weighed I do not believe that there are trustworthy grounds for doubting the exactness of the hypothesis that in the genus *Scalpellum* the hermaphrodite condition is the original, and the unisexual the secondary stage in the development.

[1] I did not observe the male of *Scalpellum trispinosum*. I suppose that this species is furnished with a complemental male with capitulum and peduncle from its resemblance to the species *Scalpellum villosum*. I did not study its genital apparatus. I can only say that it is furnished with a well-developed penis.

II. SEGMENTAL ORGANS IN THE CIRRIPEDIA.

Cirripedia are rich in organs of an unknown or at least problematic function. One instance of these is found in the "olfactory organs" or sacs of Darwin. "In the outer maxillæ," Darwin says,[1] "at their bases where united together, but above the basal fold separating the mouth from the body, there are, in all the genera, a pair of orifices; these are sometimes seated on a slight prominence, as in *Lithotrya*, or on the summit of flattened tubes projecting upwards and towards each other as in *Ibla*, *Scalpellum*, and *Pollicipes*. In *Ibla* these tubular projections rise from almost between the outer and inner maxillæ. It is impossible to behold these organs, and doubt that they are of high functional importance to the animal. The orifice leads into a deep sack lined by pulpy corium, and closed at the bottom. The outer integument is inflected inwards (hence periodically moulted) and becoming of excessive tenuity, runs to near the bottom of the sack, where it ends in an open tube; so excessively thin is this inflected membrane, that until examining *Anelasma*, I was not quite certain that I was right in believing that the outer integument did not extend over the whole bottom. I several times saw a nerve of considerable size entering and blending into a pulpy layer at the bottom of the sack of corium; but I failed in tracing to which of the three pair of nerves, springing from the front end of the infra-œsophageal ganglion, it joined. I can hardly avoid concluding that this *closed* sack, with its naked bottom, is an organ of sense; and, considering that the outer maxillæ serve to carry the prey entangled by the cirri towards the maxillæ and mandibles, the position seems so admirably adapted for an olfactory organ, whereby the animal could at once perceive the nature of any floating object thus caught, that I have ventured provisionally to designate the two orifices and sacks as olfactory."

This supposition of Darwin's has, however, been accepted with great reserve. As far as my knowledge of the literature of the group goes, the same organs have not been studied, nor has another opinion been published about their function since Darwin's.[2] I first tried to get a good insight into the structure of this apparatus by isolating the outer maxillæ. I arrived at the same conclusion as Darwin, viz., that it was composed of a duct with an outward orifice and an internal portion, a kind of sack lined by a layer of cells different in structure from those of the duct. In some of the figures representing parts of the mouth of species of the genus *Scalpellum* (*e.g. Scalpellum parallelogramma*, *Scalpellum strömii*, &c.), in the systematic part of my report, the long and very characteristic tubes at the extremity of which the orifices are found have been represented. I then studied the apparatus by the aid of transverse sections of the thorax of the

[1] Darwin, Lepadidæ, 1851, p. 52.

[2] Claus (Lehrb. d. Zool. 3 Aufl. 1876, p. 456, says:—"Gehör- und Geruchsorgane sind nicht mit Sicherheit nachgewiesen, da die von Darwin als solche in Anspruch genommenen Bildungen eine andere Deutung (Oviducte, Drüsenöffnungen) erfahren haben." I do not know where this opinion has been published, so far as Darwin's olfactory organ is concerned.

animals, and I then became certain that Darwin's description was not correct in one very important point. The sack is not closed at the bottom, but gives entrance to the body-cavity of the animal.

For want of material I have been obliged to limit my researches to the pedunculated Cirripedia; in the sessile Cirripedia, however, there cannot be the slightest doubt that the apparatus will prove to have about the same structure; the orifices are here never produced nor tubular.[1] I got by far the best preparations from specimens of *Scalpellum vulgare*, Leach, which I received from the Zoological Station at Naples. The figures on Pl. V., as well as the description, are based upon preparations of these specimens.

Fig. 1 of Pl. V. shows a complete transverse section through the thorax of *Scalpellum vulgare* a little below the first cirrus. The large cavities (*A*) separated in the figure from one another by the band of connective tissue (*B*) represent parts of the body-cavity. An epithelial clothing (a true cœlomic epithelium) cannot everywhere be made out distinctly; yet I think its presence may be safely concluded from the cellular remains which here and there adhere to the connective tissue, in the shape of elongate and rather flat nuclei. The section passes longitudinally through the long and flattened tube which belongs to the right outer maxilla; the duct on the interior is clothed by a thin chitinous tunic, with a chitinogenous epithelium everywhere beneath it; both the chitinous tunic and its matrix are the continuation of the outer body-wall, and are no doubt true epiblastic products. Fig. 3 of Pl. V. represents a longitudinal section of one of the segmental organs. From the outer wall of the flattened tube thin transverse fibres of connective tissue run towards the wall of the duct. Having passed longitudinally through the tube, the duct may be traced for a short distance beneath the surface of the body; it then passes over into a very narrow channel which passes through a compact mass of cells. The whole mass of cells has the shape of a bell; the limits of the different cells are not very distinct, but the different nuclei are. They are oval and their longest diameter is about 0·005 mm. (fig. 2, Pl. V.) The surface of the cells bordering the narrow channel is markedly protuberant, so as almost to meet that of the opposed cells; in very favourable sections only can the presence of the channel be made out. To judge from the great number of nuclei, the cell-mass, at least on one side, is formed of more than a single layer. Whereas the cells of the duct have their nuclei with their longer axis parallel to the surface of the wall of the duct, those of the bell-shaped cell-mass are rather perpendicular to the surface of the very narrow channel. Moreover, the latter are very characteristic on account of their staining much more intensely than do those of the chitinogenous cells or of the surrounding connective tissue. Towards the interior of the body-cavity the thick cell-coating of the narrow channel slopes and soon terminates; from the body-cavity the entrance of the narrow channel is distinctly funnel-shaped. The chitinous membrane which clothes the interior of the duct is not present at the surface of

[1] Darwin, Balanidæ, 1854, p. 97.

the cells which border the narrow channel. (Probably we have here the explanation of what Darwin means, when he says that the outer integument is inflected inwards, and ends in an open tube.)

I propose to call the duct which opens at the extremity of the tubes the "segmental duct," and the bell-shaped cell-mass with its very narrow channel the "segmental funnel." I think we can hardly hesitate to consider these organs as true segmental organs, but before entering into a discussion of the arguments in favour of this suggestion, I will finish the description. To the apparatus belongs also a well-developed set of muscles attached round about to the external surface of the bell-shaped cell-mass, of which especially those directed to the external side of the body, are very strongly developed; they form towards the interior of each organ a nearly triangular mass, the apex of which is directed towards the interior of the body, the broad basis being placed against the outer surface of the bell-shaped cell-mass (Pl. V. fig. 2). The muscle-fibres of the external side of the cell-mass are distinctly divergent, and a part of them continues in a rather strong bundle of muscle-fibres running towards the border of the body-cavity. In my most successful, thinnest, and best stained preparations the muscle-fibres did not show transverse striation; those especially of the external side were remarkable for their clearness and smoothness, resembling thin elastic fibres of the connective tissue. Between these fibres interspaces may be seen everywhere, and in these numerous pale small round cells were visible, which I think were blood-corpuscles. Probably the function of the muscle-fibres is not in the first place to move, but to form a labyrinth of small cavities in which the blood accumulates.

What may be the morphological significance of this organ? Considering that it constitutes an open communication of the body-cavity with the exterior, there can be no doubt that it must be compared with the segmental organs of the Annelida. The high development in the genus *Scalpellum* of the flattened tube at the end of which the orifice is found, shows, I think, that we have not before us a rudimentary organ, but an apparatus of an important functional significance. From a phylogenetic point of view its importance increases with our knowledge of the great age of Cirripedia, of which, *e.g.*, the present genus is already represented in the Lower Greensand. Where the shell has remained exactly the same, we can safely admit that the structure of the animals is sure to have changed very little or not at all since that remote geological period.

A rather curious circumstance is found in the fact that in Cirripedia only one pair of segmental organs has remained. In the oldest Tracheate Arthropoda we know of (*Peripatus*), according to Balfour,[1] there are found nephridia or segmental organs in all the legs; in Crustaceans these same organs have not been observed with certainty; the only instance mentioned in literature is that of terrestrial Isopods, where M. Huet[2]

[1] F. M. Balfour, The anatomy and development of Peripatus capensis, *Quart. Journ. Micr. Sci.*, vol. xxiii. pp. 213–259, 1883.

[2] Huet, Sur l'existence d'organes segmentaires chez certains Crustacés isopodes, *Comptes Rendus*, 1882, No. 12, p. 810.

believes he has observed segmental organs in each of the seven body segments. Whether M. Huet be right in considering these organs "organes glandulaires . . . qui s'ouvrent à la partie supérieure des épimères, de chaque côté, par une ouverture en crible" as segmental organs, I will not discuss. To judge from his description they have not the typical structure of true segmental organs which are to form an open communication between the body-cavity and the exterior.

Two other sets of glands of Arthropoda, and more especially of Crustaceans, are perhaps more nearly related to the segmental organs; they are the antennal glands of the larvæ of many Entomostracans and of the full-grown Malacostracans; and the shell-glands of full-grown Copepoda and Phyllopoda. According to Grobben[1] they have nearly the same structure, and must be regarded as homologous organs (homodynamous they are called, more accurately I think, by R. and O. Hertwig[2]); both are composed of a little terminal sack (Endsäckchen), and a channel (Harnkanälchen) which opens at the surface of the body. Moreover, the cells covering the interior of the little sack in the antennal and shell-glands show a complete resemblance. An open communication with the body-cavity has, however, never been observed in the case of these organs[3]; if they really are to be compared with segmental organs, there can be no question that they have degenerated from their original condition.

Should there ever be discovered an intermediate form between a true segmental organ such as that of *Scalpellum* and a shell-gland as observed in the Copepoda, then in the first place the homology of the apparatus may be accepted; but in the second place it will then also be possible to give a more solid basis for demonstrating the homologies of the extremities of Cirripedia and Copepoda than has been the case hitherto. When treating of the female genital apparatus and its orifice at the base of the first cirrus I hope to point out that there is sufficient reason for admitting that a second pair of segmental organs, though in a slightly modified condition, is present in the Cirripedia also.

Finally, I will not take leave of this subject without stating as my opinion that the segmental organ which I have described is physiologically an organ of an excretory nature. The condition of the material at my disposal did not allow of my attempting a chemical investigation of the contents of the cells, and so it is only from analogy that this conclusion has been arrived at. It is fairly supported, I think, by the presence of muscle-fibres with numerous cavities between them, such as have also been observed by Grobben (*loc. cit.*, p. 105) in the neighbourhood of the antennal glands of the Decapoda.

[1] C. Grobben, Die Antennendrüse der Crustaceen, *Arb. Zool. Inst. Wien.*, Bd. iii. 1880.

[2] R. and O. Hertwig, Die Coelomtheorie, *Jenaische Zeitschr.*, Bd. xv. pp. 1–150, 1882.

[3] According to Sedgwick (*Quart. Journ. Micr. Sci.*, vol. xxiv., N.S., pp. 46, 47, 1884), the nephridia of the Invertebrata are developed from solid masses of cells derived from the wall of the cœlom; a communication with the body-cavity in that case would represent a secondary stage.

III. THE CEMENT APPARATUS.

The cement apparatus and the genital organs of the Cirripedia are in general tolerably well known; in detail, however, our knowledge often proves to be very insufficient. Darwin has the merit of having discovered the presence of the cement-apparatus, but he failed to understand its organisation, partly because he confounded its elements with those of the female genital apparatus.

Krohn[1] gives a much more accurate description of the cement apparatus of *Lepas anatifera* and *Conchoderma virgatum*. He was the first to observe the true cement-glands. In *Lepas anatifera* they are, according to him, situated in the most superior part of the peduncle, and scattered through the connective tissue which envelops the ovary; they are very numerous, and they have the shape of long oval, vesicular little bodies, which are attached to very delicate and richly ramified canals in the same way as berries to their stems. These canals open, before the inferior extremity of the ovary is reached, into the two cement-ducts, the commencements of which are swollen into ampullæ. These cement-ducts have been already observed by Darwin; they run downwards at a considerable distance from one another, one at the right, the other at the left hand side of the peduncle, and they are situated close to the innermost layer of longitudinal muscle-fibres. Finally they penetrate into the chitinous wall of the peduncle near the place where it is attached; they pass through this wall, becoming narrower and narrower, and are then lost sight of. In the deeper layers of the chitinous wall of the peduncle the cement-ducts are invested with rounded swellings of different sizes, which are hollow and which are doubtless in open communication with the ducts; these swellings act as reservoirs to retain the cement before it is evacuated. In *Conchoderma virgatum* the cement-apparatus differs from that of *Lepas anatifera* in the cement-glands being for the greater part placed in the parenchymatous tissue of the mantle and for a very small part only in the superior extremity of the peduncle. The two cement-ducts with their swollen ampullæ reach very close up to the place where the capitulum communicates with the peduncle. The two ampullæ in this genus communicate with one another by means of a transverse and tortuous canal.

I studied the cement apparatus in *Lepas*, *Conchoderma*, and *Scalpellum*. As regards the histological structure of the apparatus my researches are far from satisfactory, the condition of the material at my disposal being, in part at least, the cause of this. The peduncle of the Cirripedia is very difficult to preserve; even in specimens freshly sent over by the Direction of the Zoological Station at Naples, the condition of the tissue has suffered much.

The little bodies which were considered by Krohn as the true cement-glands must

[1] A. Krohn, Beobachtungen über den Cementapparat und die weiblichen Zeugungsorgane einiger Cirripedien, *Archiv f. Naturgesch.* Jahrg. xxv. Bd. i. pp. 355–364, 1859.

indeed be regarded as such. Krohn has not given a description of these glands, nor is such a description to be found in the literature of the group. For *Balanus* I myself published figures of these glands some years ago,[1] when it was my opinion that the ovarian cœca might perhaps develop from these bodies—a serious error pointed out by Claus. My excuse was firstly that these bodies, scattered everywhere between the young ovarian cœca, had never been observed in a sessile Cirriped before, and secondly that Darwin had led me into error by describing the cement-glands as adhering to the basal membrane or basal calcareous plate of the Balaninæ. I should have paid more attention to a footnote in Krohn's paper (p. 357), in which he states his opinion that the true cement-glands of the Balanidæ might also be found between the ovaries or in the connective tissue surrounding the mantle.

The cement-glands of *Lepas anatifera*, of *Conchoderma virgatum*, and of *Scalpellum vulgare* are nearly of the same shape and size. Those of *Lepas anatifera* are a little larger, the longest diameter measuring 0·15 to 0·2 mm., whereas those of *Scalpellum vulgare* are smaller, having a diameter of about 0·125 mm. (The largest diameter of one of the cement-glands of *Balanus improvisus* is not quite 0·2 mm.). The interior of the cells is filled with a plasmatic mass, which shows the curious property of staining rather intensely with aluminium carminate. At the same time, the large nucleus, which occupies nearly the centre of the cell, and which measures half the length of the cell itself, is coloured also and much more intensely. In many preparations the body of the cell shows an extremely delicate granular structure, whereas the nuclei are coarsely granulated, or appear to have a fibrillar structure. In *Lepas* nucleoli have not yet been observed. Pl. II. fig. 5 shows the condition of the cement-cells in the Cypris-larva. I do not quite understand in what way the pear-shaped gland develops from these cells. The size of the latter is about 0·03 mm., at least in the case of *Lepas australis*. Towards one side, and as a rule in the longer axis of the cell, its wall is produced so that the cell assumes the shape of a pear; this produced part slopes into a long and narrow duct (Pl. V. fig. 5). The structure of this duct is very simple; here and there small cells are visible in its wall (measuring about 0·005 mm.), which on the exterior is lined by a kind of thin cuticle.

The ducts of the different cement-glands unite together to form a much more capacious duct; a little before the place where the junction is observed, a transverse short duct often runs from one branch to the other; all the ducts together form an irregular network, the thickest branches finally pour out their contents into two longitudinal ducts. The ducts (fig. 5, *d*), which communicate directly with the glands, have a diameter of about 0·025 mm.; the two longitudinal ducts in which the contents of the narrow ducts are evacuated, measure about 0·05 mm. in width. In a

[1] P. P. C. Hoek, Zur Entwickelungsgeschichte der Entomostraken, I. Embryologie von Balanus, *Niederländ Archiv f. Zool.*, Bd. iii. pp. 47–82, 1876.

large series of sections of the peduncle of *Lepas anatifera*, the presence of the principal cement-ducts can everywhere be ascertained; in the most superior part of the peduncle they run at a somewhat greater distance from the innermost layer of longitudinal muscle-fibres than is the case in the more inferior sections of the peduncle. The ampullæ which would represent the commencements of the cement-ducts I have not observed. The two ducts run in a zig-zag line, whence in many sections parts of them 0·3 mm. in length are represented. I have not been able to follow the cement-ducts quite up to the inferior extremity of the peduncle. The wall of the duct itself is irregularly folded in all my preparations of *Lepas anatifera*; towards the interior of the canal it seems to be invested with a thin cuticle, for, when a transverse section is studied, its interior is always limited by a sharp smooth line; for the rest, I have not a very clear notion of the cellular structure of the canal. The condition of the specimens of *Conchoderma virgatum* at my disposal has only allowed of my making a preparation of the glands. They are very small, measuring not quite 0·06 mm. Their nuclei are nearly circular, and have a diameter of about 0·024 mm. In one of the glands a little nucleolus was visible, though not very distinctly. The thin cuticle which invests the canal that passes away from the gland in *Conchoderma virgatum* was visible also round the glands themselves. I found Krohn's statement as to the occurrence of the cement-glands for the main part in the parenchymatous tissue of the mantle to be quite correct.

In *Scalpellum* I studied the cement-apparatus in two species in greater detail, viz., in *Scalpellum vulgare*, Leach, and in *Scalpellum regium* (Wyv. Thoms.), Hoek. In these two species this apparatus is, curiously enough, not quite built up after the same type. That of *Scalpellum vulgare* has been described already by Darwin.[1] In young specimens, Darwin says, the attachment is performed by cement proceeding exclusively from the antennæ of the larva; in older and full-grown specimens the cement is poured out through a straight row of orifices along the rostral edge, thus causing a narrow margin to adhere firmly to the thin and cylindrical branches of the coralline. "At each period of growth the corium (the soft flesh, the mass of connective tissue with the muscles of the peduncle) recedes a little from the attached portion of the peduncle; of which portion the greater part is thus left empty, &c. . . . The two cement-glands are seated high up on the sides of the peduncle; the two cement-ducts proceeding from them, are $\frac{3}{200}$ths of an inch (0·039 mm.) in diameter and run in a zig-zag line; at the point where they pass through the corium to enter the lower attached portion of the peduncle they become closely approximated, and partially imbedded in the membrane of the peduncle. They run together along the rostral edge, giving out through each orifice a little disk of brownish cement, and finally they enter the larval antennæ."

The specimen of *Scalpellum vulgare*, whose cement-apparatus I have investigated, had a peduncle of about 9 mm. in length, and was attached by its under surface

[1] Darwin, Lepadidæ, 1851, p. 226.

to the rather broad stem of a horny coral. In order to be able to make transverse sections of the peduncle, I have removed the chitinous wall of the peduncle with its calcareous scales. I stained the peduncle *in toto* by means of aluminium carminate. The ovary in this specimen was very strongly developed, and its cœca extended as far as the most inferior part of the peduncle. The true cement-glands have nearly the same shape and structure as in the other genera; in size they are larger than those of *Conchoderma*, but not so large as those of *Lepas*. They are rather numerous in the superior part of the peduncle, but become scarce lower down (Pl. V. fig. 6). On opening a peduncle of *Scalpellum vulgare* in alcohol, the glands appear as little white grains, and are visible even with the naked eye. Often the glands are not unicellular but composed of two or three cells combined; in that case the body of the gland is larger, and the two or three nuclei of the original cells are distinctly visible. In many of the glands a dark coloured oval nucleolus was present within the circular nucleus (Pl. V. fig. 6*); the size of the gland was 0·11 to 0·125 mm. in diameter, that of the nucleus 0·04, whereas the nucleolus measured 0·013 mm. The ducts at the end of which the glands are observed are very narrow, their diameter being about 0·007 mm.; those of adjoining glands often anastomose, so as to form together a network of ducts. I know these anastomosing canals from a preparation stained with picrocarmine and isolated by the aid of needles. In the transverse sections of the peduncle only very small parts of the ducts are seen attached to the glands.

All the narrow ducts pour their contents into four rather wide canals which, at the rostral side, run longitudinally through the peduncle. Immediately below the place in the superior part of the peduncle, where the two oviducts terminate, the first longitudinal cement-duct begins (Pl. V. fig. 6, *d*). It is closed at its superior extremity, the cement being shed in the canal by means of lateral openings. The blind extremity of the canal is placed a little more towards the centre of the peduncle; the canal slightly changes its direction so as to run parallel with and close to the elongated cavity (fig. 6, *a*), which is visible at the rostral side of most pedunculated Cirripedia (*Lepas*, *Conchoderma*, *Scalpellum*), and which is a continuation of a part of the body-cavity of the animal within the capitulum. The width of the cement-duct is about 0·3 mm. It is surrounded by a chitinous wall—perhaps the chemical composition is different from that of chitin—and it shows traces of an epithelial (or rather endothelial) cell-layer on the internal surface. About half-way along the peduncle a second longitudinal canal begins; it has, when seen in transverse section, a long oval shape, and is divided by a partition into two halves, which soon become independent. A little lower a third—properly speaking a fourth—canal begins (Pl. V. fig. 7). It has an oval shape; its largest diameter is 0·4 mm., its shortest 0·28; its wall is composed of a chitinous (?) outer layer and a regularly developed inner epithelial layer of very small cells with distinctly coloured nuclei. I do not quite understand why this epithelial cell-layer is well developed (at least distinctly visible) in the one duct, whereas it can scarcely be made out in the other ducts.

After the four canals have run independently of one another for about 1½ mm., the first duct unites with one of the two ducts into which the second canal has divided, whereas the other half of the second duct terminates by uniting with the third. In the lowest sections of the peduncle of *Scalpellum vulgare* which I have been able to investigate, two ducts only are present. They run close to one another, and are placed within the wide canal which in the peduncle represents the cœlom. Of course higher up in the peduncle they were situated in this canal also; but at the place where they commence with a blind extremity, as a rule, they are not within this cavity. All the canals have very irregularly folded walls, and are filled up with a solid mass of a granular structure. Probably this is the cement after it has been affected by alcohol and reagents. At many places part of the chitinous (?) and irregularly folded wall is stained also by the aluminium carminate.

The way in which the cement is poured out into the canals has not been observed by me. Everywhere round the canals a dense layer of connective tissue with numerous nuclei is observed, and at the places where the wall of the ducts is open, a spongy mass of this tissue penetrates within the opening. Most probably the connective tissue is charged with the duty of conducting the cement till it comes within the canals. The communication of the microscopic canals, at the end of which the glands are placed, with the cement-ducts—or with the connective tissue surrounding these ducts—has not been observed. I think it impossible to observe this without the aid of very rich and fresh material.

The cement-glands of *Scalpellum regium* (Wyv. Thoms.), Hoek, are not numerous, but they are relatively large. They are placed in two groups in the superior part of the peduncle to the right and to the left side (Pl. V. fig. 8). As a rule, each gland is composed of three or four glandular cells (Pl. V. fig. 11). I measured a gland which appeared to me to be unicellular, and its greatest diameter was 0·5 mm.; another composed of three cells had a length of 0·7 mm. The nuclei in the glands of this species have a very characteristic fibrillar structure; it is, of course, possible that the reagents have caused this. The ducts going off from the cells are narrow (their diameter being 0·016 to 0·02 mm.); the nuclei of the cells forming their walls are very distinct. The walls of these ducts are not quite smooth; globular vesicles adhere to them as small excrescences, and so give the duct, especially when studied in transverse section, a very curious aspect (Pl. VI. fig. 3). The ducts unite together so as to form groups of nearly parallel ducts, but often many of them retain their independence. Often two groups of ducts reunite, to become isolated again after a short time. About the middle of the peduncle I counted more than twenty groups of these ducts; some were composed of three or four single ducts, others of more (Pl. V. fig. 10). In the centre of each group of ducts often a much wider duct is visible; especially wide is a duct which runs at the rostral side of the peduncle close to the innermost layer of muscular fibres (Pl. V. fig. 10; Pl. VI. fig. 3).

This wide duct may be seen to continue as far as the uppermost part of the peduncle,

and is nothing else but the cavity (A) which we observed also in the peduncles of the other Lepadidæ, and which can be traced as a continuation of a part of the cœlom. In the superior part of the peduncle (Pl. V. fig. 8) this wide canal (measuring here 0·9 by 0·56 mm.) has an oval shape, and is completely filled with a very delicately granulated mass, which I think more resembles blood serum than any other substance. The connective tissue surrounding this canal, and especially the interior of the peduncle, has a very spongy structure; as I shall point out again when treating of the development of the ovaries within the peduncle, I think the contents of the duct and the tissue which surrounds it serve to nourish the ovaries.

At a short distance—about 3 mm.—from the superior extremity the duct begins to get narrower; the space occupied by the delicately granulated substance measures now only 0·22 mm. in diameter. The spongy mass of connective tissue has grown much thicker, and forms especially towards the interior of the peduncle a very thick wall; for the first time here cement-ducts are seen within this thickened portion of the wall of the duct (Pl. V. fig. 9). Between this wall and the central mass of the granulated substance a layer of vesicles can be distinguished. I think they are formed by the cement poured out into the canal and pressed between the wall and the central mass. One millimetre and a half farther down the duct becomes still narrower; it now has with its wall a diameter of 0·43 mm. only. The granulated substance has almost totally disappeared, but the interior of the wall is everywhere covered with large and small cement vesicles. Below the middle of the peduncle, at numerous places, larger cement-ducts pour out their contents into this canal, which eventually has in all respects the shape of one of the wider cement-ducts such as are found also in the interior of the peduncle. In the undermost part of the peduncle it runs no longer close to the rostral side, but is observed in the centre of the peduncle. It there quite resembles two other larger cement-ducts which run longitudinally through the peduncle. Probably these ducts are open at their inferior extremities, which, so far as I could make out, are not continued up to the base of the peduncle; the latest sections I prepared of the peduncle do not show the ducts in the connective tissue.

So we see that in *Scalpellum regium*, the cement-ducts do not run within the cœlom-cavity, or what I feel inclined to consider as its homologue, but that this cavity in its most inferior part is itself changed into such a cement-duct. The other ducts stand in open communication with the one at the rostral side. A second difference is seen in the structure of the wall of the ducts; the smooth-lined sheath of the ducts in *Scalpellum vulgare*, which made me compare the substance of which that wall is built up with chitin, is nowhere to be observed in *Scalpellum regium*. No doubt the investigation of other species of *Scalpellum* and of other genera of Cirripedia will show that the cement-apparatus of this group of Crustaceans presents many more variations than would have been expected beforehand. The knowledge of these variations is no doubt of great interest, yet it would be of much more importance still, if the morphological significance of the apparatus were more apparent.

IV. DARWIN'S "TRUE OVARIA."

Darwin[1] observed in the Cirripedia two glandular masses resting on the upper edge of the stomach, and touching the cœca where such exist; these were thought by Cuvier to be salivary glands. They are of an orange colour and form two parallel "gut-formed" masses. Darwin was not able to ascertain whether the two main ovarian ducts coming from the peduncle expanded to envelop these glandulæ or what the precise connection was. He says "the state of these two masses varied much; sometimes they were hollow, with only their walls spotted with a few cellular little masses; at other times they contained or rather were formed of more or less globular or finger-shaped aggregations of pulpy matter; and lastly, the whole consisted of separate pointed little balls, each with a large inner cell, and this again with two or three included granules. These so closely resembled in general appearance and size the ovigerms with their germinal vesicles and spots, which I have often seen at the first commencement of the formation of the ova in the ovarian tubes in the peduncle, that I cannot doubt that such is their nature. Hence I conclude that these two gut-formed masses are the true ovaria. I may add that several times I have seen in the two long unbranched ducts, connecting the true ovaria and the ovarian tubes in the peduncle, pellets of orange-coloured cellular matter (*i.e.*, ovigerms) forming at short intervals little enlargements in the ducts, and apparently travelling into the peduncle."

In the second volume of Darwin's Monograph,[2] the same opinion as to the nature of these glandular bodies was given for the sessile Cirripedia. This opinion, however, was not only opposed to that of Cuvier[3] but also to that of Martin-Saint-Ange and of Karsten. Martin-Saint-Ange[4] describes "une espèce d'appendice stomacal, un véritable prolongement renflé et bilobé, communiquant avec la première cavité de l'estomac par un pédicule étroit et fort court. La structure, la forme générale, la coloration et la disposition mamelonnée de la surface extérieure de cette partie sont tout à fait semblables à celle de l'estomac, et doivent être regardées comme faisant partie du même organe." Martin-Saint-Ange, therefore, cannot be said to have considered these bodies as salivary glands, since he points out in his Memoir as well as in the explanation of the figures that these organs communicate with the stomach. So Darwin's objection "that salivary glands have not been positively recognised in any Crustacean" cannot be considered of any consequence.

Krohn,[5] describing the direction followed by the oviducts, says that they approach very

[1] Darwin, Lepadidæ, 1851, p. 57.

[2] Balanidæ, 1854, p. 100.

[3] Cuvier, Mémoire sur les animaux des Anatifes, *Mém. Mus. Hist. Nat.*, t. ii., 1815.

[4] Martin-Saint-Ange, Mémoire sur l'organisation des Cirripèdes, *Mém. Inst. Savans. Étrang.*, t. vi., 1835.

[5] Krohn, Ueber d. Cement- und Zeugungsapparat d. Cirripedien, *Wiegmann's Archiv*, t. xxv., 1859.

close to those organs "die seit Cuvier für die Speicheldrüsen gelten." For the rest he does not say what is his own opinion in regard to the nature of these bodies.

I do not think that since the publication of Darwin's Monograph these organs have been investigated; so I was most anxious to study them, and if possible to make out their structure. They occurred in all the genera in which I sought for them; I studied them in greatest detail in the genera *Lepas* and *Scalpellum*.

Near the place where the œsophagus communicates with the stomach, the outer surface of this latter organ is invested with a pair of oval masses; they are placed at rather a considerable distance from one another, one being found at the right, the other at the left hand side of the stomach. Pl. VI. fig. 7 shows their situation in *Lepas anatifera* when seen laterally, fig. 8 when seen from the anterior (dorsal) side. In both figures *Œ.* represents the œsophagus and *G. S.* the supraœsophageal ganglion; *p. n.* are the two strong peduncular nerves which start from the supraœsophageal ganglion; *oc.* is the curious eye discovered by Leidy, placed close to the surface of the stomach and separated from the external surface of the body by a very darkly pigmented integument and a thick layer of muscles, which are both left out in the figures. The oviducts (*ov*) are also distinct in both figures. They come from the peduncles and for some distance run parallel to the peduncular nerves; a little beyond the eye they are seen to diverge and then may be followed running transversely over or at least close to the surface of the stomach. Dorsally from the oviducts (in fig. 7 beneath them) the most anterior parts of the testis (*t*) can be distinguished. That part of the surface of the stomach which is nearest to the œsophagus is covered all over with rounded and dark-coloured tubercles (*l*) which cause the "disposition mamelonnée" of Martin-Saint-Ange, and which when studied in a transverse section appear to be the arborescent cœca of the surface of the stomach. The internal surface of these cœca is darkly pigmented, and this causes the blackish colour of the rounded swellings at the exterior.

The glandular bodies in figs. 7 and 8 are marked *gl.* They are not always of the same shape and size. Sometimes they are rather regularly oval and compact, having a length of about 4 mm. and a breadth of not quite 2 mm. In other cases, however, finger-shaped excrescences (as observed by Darwin) give the gland a much more irregular appearance. In both cases the surface of the body is uneven owing to the presence of globular swellings; whilst the whole body represents an acinous gland, each of the globules being a distinct acinus.

Before giving a description of the microscopic structure of the gland in *Lepas* I will describe its structure in *Scalpellum*. My best preparations are from *Scalpellum parallelogramma*, Hoek. In this species the gland is relatively small, having a length of little more than one millimetre. It is pyriform; at the narrow extremity it communicates with the interior of the stomach by means of a very narrow duct; at the other extremity its body is rather blunt and rounded. The greatest transverse diameter of the gland in

one of my series of sections measured 0·6 mm. In another series, however, it was more oval and measured 0·9 by 0·5 mm. The gland is not situated near the cardia but at a considerable distance, about half-way between the cardia and the dorsal surface of the body. The gland is a true tubular one; its wall consists of a single layer of cells only. The shape of these cells may be seen in Pl. VI. figs. 4 and 5. Each cell is cylindrical or rather conical, its base always being greater than the other extremity, which is directed towards the interior of the gland. The bases of the different cells are parallel to the nearly smooth outer surface of the gland; the other extremities of the cells, however, are as a rule not flat but convex, or even protuberant towards the interior of the canal which runs through the gland. In thin sections the outer surface of the gland is marked by a double line; the outer one is here and there distinctly sinuous, and between the two lines small nuclei are visible, which are rather flat; they are placed in the cavities between the inner and the outer margin. There can be no doubt that in this way a rudimentary *membrana propria* is formed. The connective tissue surrounding the glands has smaller meshes and is very rich in nuclei.

The dimensions of the glandular cells are about 0·1 mm. in length and 0·03 mm. in breadth. Each cell has granular plasmatic contents and a very large oval nucleus. In preparations stained with aluminium carminate the body of the cell as well as the nucleus has taken up the colour. The first is beautifully lilac-coloured, the latter darkly violet. Each nucleus is coarsely granulated and measures 0·036 by 0·02 mm. It contains a smooth and brilliant nucleolus of 0·009 mm. in diameter. In each nucleus the nucleolus is situated in the centre of a clear space, which, as a rule, is placed towards that side of the nucleus which is directed towards the internal surface of the gland. The clear space—which gives the impression of a clear vesicle with fluid, but which has no distinct contour of its own—is on one side separated from the surface of the nucleus only by a very narrow layer of the granular substance which fills the nucleus. The nucleus has a distinct external contour.

All the cells are built after the same type; but there are very characteristic differences between the cells of two different specimens of *Scalpellum parallelogramma*. In the first place there is a very marked difference in size; the length is nearly the same (0·09 mm.); the breadth, however, measures only 0·013 mm. and the nuclei are not, as in the first specimen which I investigated, placed close to the internal surface of the glandular cells, but beyond the middle: they are nearer to the external than to the internal surface. The structure of the nuclei is the same; they are more elongate and slightly pointed towards the outer extremity.

In a series of sections through the cephalic part of the body of *Scalpellum nympho-cola*, these glands which I propose to call "pancreatic glands" are also represented. In this species the form of the gland is the same as in *Scalpellum parallelogramma*, the

transverse sections are circular or nearly so. The nuclei of the cells of the gland are all situated at the periphery close to the membrana propria which envelops the body of the gland.

The structure of the gland in *Lepas* will now be easily understood. Let the wall of the gland in *Scalpellum* develop excrescences, so that the interior of each excrescence communicates with the interior of the original or main part of the gland, and the tubular gland will have changed into an acinous one. The excrescences have as a rule the shape of globules, but they may also be elongated so as to form finger-shaped appendages. When the gland is divided by transverse and parallel sections in a series of preparations the shape and size of the cells are by no means so uniform as in the case of *Scalpellum*. This, of course, is partly in consequence of the sections not always cutting the cells in the same direction, though parallel. In some of the sections the cells are cylindrical, having a length of 0·1 mm. and a breadth of 0·026 mm. If these same cells had been cut transversely to their longest axis, their length would have appeared much shorter. The size of the oval nuclei is 0·016 mm. In the more tubular parts of the gland the cells are not so high and their walls not so parallel; in the sections, therefore, they are almost triangular or flattened quadrangularly; between them I observed here and there larger cells with very capacious nuclei. I measured one of the cells, the length of which was 0·13, whereas its breadth was 0·9 mm. It was furnished with a nucleus 0·05 mm. in diameter. The only difference which I could make out between the different cells of each gland was, however, in size; in regard to their staining with aluminium carminate, I must point out a very striking correspondence of these cells to those of the cement-apparatus of the peduncle, viz., the body of the cells is always beautifully lilac-coloured, the nuclei appearing dark violet. The latter are remarkable, in the same way also as those of the cement-glands, since coarse granules and even fibres fill their interior. A distinct membrana propria surrounds the body of the gland in *Lepas* as well as in *Scalpellum*.

The gland communicates with the interior of the stomach by means of a narrow duct which opens close to the cardia in an interspace between two of the so-called hepatic excrescences.

As to the function of these glands a few words may suffice. That they are not true salivary glands needs no further proof. At the same time it can hardly be doubted that their function is that of a digestive organ which pours its secretion into the alimentary canal. Whereas the recent interesting researches of Max Weber[1] have cast light upon the structure and function of the digestive glands (Verdauungsdrüsen) of the higher Crustacea (*Isopoda*, *Amphipoda*, *Decapoda*), we are still almost entirely ignorant of their occurrence, functions, structure, &c., in the different orders of Entomostraca. The supposition of Claus, that the name of liver in invertebrate animals has often been used

[1] Max Weber, Ueber den Bau u. die Thätigkeit der sog. Leber der Crustaceen, *Arch. f. Mikr. Anat.*, Bd. xvii. 1879.

where in reality a pancreatic or a chyle-producing gland should be spoken of, has proved to be very important. Weber, however, tries to demonstrate that in the Crustaceans which he studied the digestive glands are built up of two kinds of glandular cells, and therefore are at the same time liver and pancreas, both modified so as to be accommodated to the organisation of the Crustacean body. Now no doubt is left that the glands of the Cirripedia are built up of *one* kind of cells only, and I think we can safely admit that these belong rather to the pancreatic than to the hepatic type. Whether the excrescences of the wall of the stomach (which are very strongly developed in *Lepas* and which are coated in the interior by a cylindrical epithelium with very small cells,[1] the nuclei of which are almost entirely hidden by a dark-brownish pigment) represent a kind of liver, I cannot undertake to say. It is indeed a curious fact—one, however, observed by Darwin thirty years ago—that these excrescences are large and well developed in some genera (*Lepas*, *Conchoderma*), and almost totally wanting in others (*Scalpellum*).

[1] The height of these cells is 0·03 mm., their breadth only 0·006 mm.

V. THE EYE OF LEPAS.

I believe Leidy was the first who observed in an adult Cirriped an organ of vision.[1] In *Balanus* there are, according to him (and Darwin has confirmed the correctness of his observation), two small eyes which stand apart from each other laterally and, owing to this discovery of the American naturalist, Darwin[2] was led to look for them in Lepadidæ. In *Lepas fascicularis* he found an elongated almost black eye composed of two eyes united together. The eye is innervated by two nerve-cords which extend from the front of the two supracesophageal ganglia, and which before reaching the eye run into two small, perfectly distinct, oval ganglia. From the opposite ends of these two ganglia smaller nerves run, and, bending in at right angles, enter the elongated eye beyond the middle.

I do not think that any description of this organ has been published since Darwin's. I made preparations of it in *Lepas anatifera* and in *Lepas fascicularis*. The place it occupies in the first species may be seen on Plate VI. figs. 7 and 8. On removing the ligament between the two scuta as well as the muscles which are here placed between this ligament and the widened stomach, the surface of the latter with its black (hepatic?) excrescences and the white pancreatic glands appear. At a distance of about 6 mm. from the supracesophageal ganglion in an adult *Lepas anatifera*, a small oval black spot is seen attached by means of connective tissue to the surface of the stomach. This is the eye. Morphologically it represents the small pigment spot which, in the Cypris-larva (Pl. II. fig. 2, *e*), is attached to the upper surface of the supracesophageal ganglion, and which is the remainder of the simple eye of the Nauplius-larva. In an adult *Lepas anatifera* it measures 0·25 mm. only in length, its breadth being not quite 0·15 mm. I believe its function to be of no consequence, in *Lepas* at least, for I do not understand how a ray of light can ever reach it, but the little organ beautifully illustrates the persistence of an old larval structure.

Most curious, however, is the fact that this rudimentary organ is indeed furnished with a kind of special ganglia (Pl. VI. fig. 9). Between the two broad (antennal) peduncular nerves, four thinner ones separate from the supracesophageal ganglion. Their thickness is not quite the same; the two outer ones are slightly stronger than the other two which lie very close to one another, almost exactly midway between the two other nerves. These four nerves can be traced up to a very short distance (about 0·6 mm.) from the small eye. Here the two stronger nerves of the four bend slightly outwards so as to approach a little more nearly to the peduncular nerves and show a distinct swelling, in the interior of which two elongate ganglionic cells are to be observed. I

[1] Leidy, *Proc. Acad. Nat. Sci. Philad.*, No. 1, vol. iv., January 1848.

[2] Darwin, Lepadidæ, 1851, p. 49.

think they can safely be described as bipolar, for their body can be followed up as a very pale process in the direction of the supræsophageal ganglion as well as in the direction of the eye. In both directions these processes are placed, like the ganglionic cell itself, quite in the interior of the nerve. Close to the eye the nerve shows a second swelling which contains also a distinct ganglionic cell, and it is by this swelling that the nerve is laterally attached to the eye. Each of the two other slightly thinner nerves, which run between the two stronger ones, has also a swelling at about the same distance from the eye. The two nerves unite together where this swelling is thickest and where each contains a ganglionic cell; they then part again and separately run towards the eye, which they reach at its frontal extremity, *i.e.*, that extremity which is directed towards the supra-œsophageal ganglion. I have not been able to study the way in which the nerves enter or are attached to the pigment spot. Round about the spot a network of fibres of greater or less capacity can easily be made out; yet it is extremely difficult, not to say impossible, to ascertain with certainty the nature of these fibres. Some of them are no doubt nerve-fibres, while others belong doubtless to the connective tissue.

The way in which the ganglionic cells are placed in the interior of the nerves slightly resembles what Leydig observed in the case of the sympathetic nerve-fibres of insects. He observed[1] (in *Bombus terrestris*) in single fibres of the so-called sympathetic nerves, a nucleus here and there with a granular mass surrounding it, forming a kind of bipolar ganglionic cell "in der Anlage."

Neither in *Lepas anatifera* nor in *Lepas fascicularis* could I distinguish the two little lenses which Darwin says he has observed. Nor do I think that this is owing to any fault in my observation. Darwin may have observed living, or at least fresh, animals, and the lenses may have disappeared under the influence of the alcohol. But I think it is more probable that Darwin, who used only a feeble magnifying power, has mistaken the ganglionic cells for lenses. What he calls the two small perfectly distinct oval ganglia, are probably the swellings of the optic nerves which in *Lepas anatifera* contain two distinct ganglionic cells.

As regards the sessile Cirripedia, and especially different species of *Balanus*, the experiments of different naturalists have shown that they are sensible to a difference between light and shadow. I do not know whether similar experiments have ever been made on pedunculated Cirripedia. Should they give the same result, and I think they very probably would, even then I should hesitate to consider the rudimentary simple eye placed on the external surface of the stomach as the organ of this function.

[1] Leydig, F., Bau des thierischen Körpers, Tübingen, 1864, p. 205.

VI. THE FEMALE GENITAL APPARATUS.

According to Darwin, the female genital apparatus consists of the true ovaria, or glandular bodies seated on each side, not far from the basal edge of the labrum; the main or unbranched ovarian ducts; and the ovarian branching tubes and cœca. The latter in the pedunculated Cirripedia are placed high up in the peduncle, and in all sessile Cirripedia lie between the calcareous or membranous basis and the inner basal lining of the sack. After the most careful and repeated examination of various Lepadidæ and Balanidæ, Darwin became convinced that there were no oviducts; he therefore supposed that the ova were brought to the surface by the formation of a new membrane round the sack underneath them, and by the subsequent exuviation of the old membrane. This supposition of Darwin's has proved to be erroneous. What Darwin called the main or unbranched ovarian duct is in reality the oviduct; it does not run up to the glandular bodies (which I have described in one of the foregoing chapters), but it passes at some distance beneath them (Pl. VI. figs. 7 and 8); it describes a curve and then enters the basal segment of the first cirrus, at the foot of which it opens.[1] Krohn was the first to describe the female genital apparatus accurately; Kossmann, though in the main agreeing with Krohn, differs from him with regard to the significance of the little shoe-shaped sack which is placed in a swelling of the oviduct near its opening. I studied the female genital apparatus in *Lepas*, *Scalpellum vulgare* and *Scalpellum regium*, in *Conchoderma virgatum* and in *Balanus*. In all essential points the results of my researches tend to confirm those of my predecessors; in detail I think I am able to add to our knowledge.

From the existence of two oviducts we may conclude that there are also two ovaries present. In the full-grown animals their numerous and strongly ramified cœca are united so intimately that they seem to form a single mass only. The cœca of the right side, however, communicate with the right oviduct, the others with that on the left.

A study of the way in which the ova are formed has given the following results. The oviduct itself is lined by a very distinct and well-developed epithelium; where the limits of the cells are not distinct, which may be due to the condition of the material at command, the nuclei are placed so regularly along the wall that even the dimensions of the epithelial cells can still be made out. Where the oviduct passes over into a cœcum of the ovary, the epithelium of the wall is no longer so distinct, and in its place nuclei are seen rather irregularly along the wall; of the true body of the cell there are only traces here and there. The ovigerms or future ovarian eggs are seen in the interior along this wall. When the ovary is mature or nearly so, we observe in the first place the large ovarian eggs, each having a nucleus with a sparkling nucleolus (Pl. VI. fig. 2) about

[1] Zool. Chall. Exp., part xxv. p. 12, pl. i. fig. 2.

the centre of the egg, and in the second place, rounded groups of very small ovigerms, forming together what the Germans call the "Keimlager." One or two of these ovigerms are often slightly larger than the rest, and these will be the first to develop into ovarian eggs after those which are already mature are evacuated.

In a ripe or nearly ripe ovarian egg of *Scalpellum vulgare* which had a diameter of 0·3 mm., a nucleus of 0·036 mm was present, having a nucleolus of 0·009 mm. The nuclei of the cells placed along the wall of the ovary are oval and measure about 0·01 by 0·005 mm.; the small ovigerms are nearly circular and have a diameter of about 0·013 mm. Their nuclei, of course, are a great deal smaller than those of the ripe ovarian eggs. One of the ovigerms was considerably larger; it was rounded oval, its diameters being 0·03 and 0·023 mm.; its nucleus was about 0·012 mm. A ripe ovarian egg of *Scalpellum vulgare* is filled with a coarsely granulated vitelline mass (Pl. VI. figs. 1*A*, 2*x*). Between the larger granules, which in the microscopical preparations appear like vesicles, a much more delicately granulated mass of plasma is here and there visible; sometimes a layer of this is placed in the centre round the nucleus. The wall of the ovarian egg seems to be a very thin and structureless membrane, and neither in the case of *Scalpellum*, nor of any of the other genera observed, was a follicular epithelium present. The mature ovarian eggs of *Scalpellum regium* are about 0·6 mm. in diameter. They are very coarsely granulated; they do not quite fill the interior of the ovarian cœca, but between them, and also between each egg and the wall of the cœcum, a layer of a much more delicately granulated mass of plasma is visible (Pl. VI. fig. 3). Here the ovigerms form groups of little cells, the dimensions of which nearly correspond to those of *Scalpellum vulgare*. In one of these groups I counted about 20 of these ovigerms. Here again one of these ovigerms was developed into a young ovarian egg. The wall of the cœca shows the same cellular elements as in *Scalpellum vulgare*; its outer surface is formed by a distinct membrana propria, which may be composed of stronger fibres of connective tissue, but which often looked as if composed of circular muscular fibres. The wall of the oviducts, however, did not show the same stronger outer wall; it is composed of a distinct epithelium and a very narrow or thin membrana propria.

Whereas in *Scalpellum vulgare* each oviduct gives off a cœcum only once, and this cœcum, which starts from the oviduct at the superior extremity of the peduncle, divides again and again, the oviduct in *Scalpellum regium* penetrates into the interior of the peduncle for about one-third of its whole length. In different places each oviduct in this species gives off cœca, and these form together so voluminous a mass that the peduncle is filled with it up to its inferior extremity.

The oviduct of *Scalpellum vulgare* appears in a transverse section as an exceedingly narrow slit, and 0·2 mm. in length. The oviduct of *Scalpellum regium* (Pl. V. figs. 8 and 9), in a transverse section shows an irregularly folded wall; its largest

diameter is about 0·55 mm., its smallest 0·15 mm. I calculated that for *Scalpellum regium* the surface of the lumen of the oviduct was about 0·09 square millimetres, whereas a section of one of the nearly ripe ovarian eggs was not less than 0·28 square millimetres. Therefore, it is either necessary that the walls of the oviducts be very elastic, or that the eggs pass through the oviduct when it is much distended. Perhaps both circumstances favour the passage of the ova.

The number of eggs laid by *Lepas* is immensely larger than by *Scalpellum*. In some of the species of the latter genus it is not even a hundred; in *Lepas anatifera* it amounts, on the contrary, to many thousands and tens of thousands. In accordance therewith, the eggs of *Lepas* are very small; I measured eggs from an egg mass of this species, and their length was only 0·24 mm. The cœca which form the ovary are very narrow and elongate, and contain rows of numerous and relatively small eggs. The ovarian egg when ripe is not so elongate as after its fecundation; I measured eggs in the oviduct, the length of which was only 0·14, their breadth being 0·1 mm. The nuclei of the eggs in the ovary are again nearly circular, and have a diameter of about 0·02 mm.; they may be seen as a rule in the centre of each ovarian egg, and contain a single very distinct nucleolus. In the cœca of younger specimens of this genus, the groups of ovigerms can be very distinctly made out. The number of ovigerms composing such a group in this genus, however, is much larger than in the genus *Scalpellum;* their dimensions do not show any considerable difference.

In *Conchoderma virgatum* the form of the cœca corresponds to that in *Lepas*. The eggs are numerous and small. I do not think it of much use to give any details as to their dimensions.

When comparing young ovarian cœca, such as are observed in the peduncles of younger specimens, with those which are gorged with numerous and larger eggs, one feels convinced that a considerable increase in bulk has taken place. This can only have been brought about by a regular and abundant supply of food. Yet it is not so very easy to understand in what way the nourishment of the peduncle is brought about. The only way is, of course, that the blood—or the fluid which in Cirripedia acts as blood—passes through the narrow band which in the pedunculated Cirripedia runs from the capitulum to the peduncle, at the rostral side near the place where the two scuta meet with their occludent margins. The two strong peduncular (antennal) nerves and the oviducts pass through this narrow commissure; but so does also a rather wide cylindrical tube which has no distinct wall of its own, and therefore is lined only by connective tissue, and which here represents the body-cavity. In those cases in which I found the ovarian eggs ripe or nearly ripe, I always found this canal totally filled up by a delicately granulated mass, which much resembled blood plasma. I therefore think it highly probable that by means of this elongate canal a regular nourishment of the peduncle and the organs placed in it is carried on. In *Scalpellum parallelogramma* I have been successful in tracing

this canal, or cylindrical cavity, to within the body of the animal. When a transverse section of the body is made near the mouth, the alimentary canal in the middle of its dorsal surface is found attached to the wall of the body by means of a rather strong band of connective tissue. Towards the hinder extremity of the body this band grows broader still, and then it appears to be perforated by a central cavity. Towards the anterior end of the body the band grows narrower, yet it may be followed up in all transverse parallel sections, as long as these contain a section of the stomach. Those sections which pass through that part of the body contained between the stomach and that stripe of the mantle which unites the two scuta, only show the band of connective tissue as a loose band attached only on one side, viz., on the dorsal internal surface of the body-wall. The two large cavities which were separated from one another by means of this band are now united. An excrescence of this cavity penetrates this part of the body in a direction vertical to the original dorsal surface, and this part of the body-cavity has one of the two sections of the oviducts on each side. It advances considerably towards the original ventral surface of the body, and now meets the two sections of the oviducts on the dorsal aspect; after having described a curve it runs longitudinally close to the rostral surface of the narrow part between the two scuta. The two oviducts are now on that side of the cavity which is directed towards the interior of the mantle-cavity, and in the same place they remain visible in the superior part of the peduncle.

The course of the oviducts through the true body of the Cirripedia can be followed up by making a dissection of it by the aid of needles. To make out its position with regard to the place occupied by the other organs a series of sections serves the purpose still better. In *Scalpellum* transverse sections through the cephalic part of the body show the oviducts on both sides about midway between the intestinal tract and the wall of the body (Pl. VI. fig. 4). It is surrounded on all sides by the connective tissue, and, as a rule, one of the larger cavities of the connective tissue is separated from the duct only by a very narrow strip of the tissue. In *Scalpellum*, as well as in *Lepas* and *Balanus* (the three genera in which the course of the oviducts has been investigated), the oviducts pass beyond the first pair of cirri. They then run upwards, *i.e.*, towards the ventral surface of the body, and bending outwards, *i.e.*, towards the lateral surface of the body, and forwards, they enter what Darwin considers the basal articulation of the first cirrus. In some of the genera (*e.g.*, *Lepas*, *Alepas*) this swelling belongs doubtless to the first cirrus; from analogy we may safely conclude that it belongs also to that pair of extremities in those cases in which (as in *Scalpellum*) no distinct relation to it can be made out. The oviduct enters this articulation at a considerable distance upwards from its base; it now describes a curve for the last time, and leads into the curious sack which Darwin considered an acoustic organ, and which opens by means of a transverse slit-like orifice at the proximal part of the basal articulation.

The structure of the wall of the oviduct may be briefly described as epithelial;

the limits of the cells are never very distinct, and their height is inconsiderable; the contents of the cell are a nucleus about 0·005 mm. in diameter and quite clear protoplasm. A very thin membrana propria covers the outer surface of the oviduct.

The way in which the oviduct corresponds with the sack in the basal articulation of the first cirrus in *Scalpellum* is different from *Lepas*. In *Scalpellum vulgare* (Pl. VI. fig. 10), and *Scalpellum parallelogramma*, the oviduct, once arrived in the basal articulation, expands so as to form a kind of funnel, which with its wide opening embraces a large portion of the curious sack which opens at the base of the swelling. The wall of this funnel closely resembles that of the oviduct. In some of my preparations the funnel is placed exactly opposite to the genital opening, in others it is attached to the sack in a more oblique direction. The curious sack, in *Scalpellum*, communicates with the genital opening by means of a long duct, the length of which equals and sometimes even surpasses that of the sack itself. At the other extremity the sack is open also and its wall round about the opening turned outward; the opening of the funnel closing exactly on the margin of the part which is turned out. In one of my series of preparations of *Scalpellum vulgare* the funnel-shaped widening of the oviduct is in close relation with a bag of connective tissue surrounding the whole sack, so that it may be traced up to where the sack goes over into the duct; at first it was my opinion that the eggs passing through the oviduct and the funnel arrived in this bag and then passed into the duct by a lateral opening situated beneath the sack, without entering the curious sack at all; but I failed to make out the existence of this opening, and since I afterwards observed the direct transition of the oviduct into the curious sack in the genus *Lepas* (Pl. VI. fig. 11), I have given up this supposition, which I must confess was rather hazardous.

The structure of the cells which compose the wall of the curious sack is that of a high cylindrical epithelium. In *Scalpellum vulgare* their dimensions are 0·02 by 0·006 mm.; each cell has a very distinct oval nucleus which, in the full-grown specimens, measures 0·006 by 0·005 mm., and which is seated very close to the free extremity of the cell. The outer surface of the sack is lined by a membrana propria with very flat nuclei. The shape of the sack in *Scalpellum* is that of a pear, the part which communicates with the duct being as a rule narrower than the other extremity. In *Scalpellum vulgare* the duct shows a small swelling near the place where it communicates with the sack, and the length of the duct is exactly equal to that of the curious sack. The wall of the duct has the same structure as the outer wall of the body, as an inflected part of which it must be necessarily considered. The limits of the cells which compose it are not distinct, its nuclei are relatively oval and large, their longest diameter being 0·009 mm. The surface of the duct is covered by a thin chitinous cuticle.

In none of the species of the genus *Scalpellum* in which I investigated this curious sack did I find it empty (*Scalpellum vulgare*, *Scalpellum parallelogramma*, *Scalpellum nymphocola*, *Scalpellum regium*, and *Scalpellum balanoides* have been investigated by means of

sections). I always observed in its interior the "flattened sack of singular shape" which Darwin called "the acoustic sack." As long as I knew this sack only from preparations of *Lepas anatifera*, young specimens of which I cut into series of sections some years ago, I really considered it with Darwin and Krohn[1] as a sack. Guided by this opinion, I wrote the passage[2] in which I gave it as my opinion that the interpretation of Krohn was more in accordance with the facts than Kossmann's; for Kossmann called the sack a "Klumpen," *i.e.*, an irregularly-shaped mass, which is sometimes quite solid, sometimes is only furnished with very irregular cavities. A glance at Pl. VI. fig. 10 will easily convince the reader that Kossmann's suggestion is now indeed mine also; the curious body looks like a compact mass, being composed of smooth layers which have probably been more or less parallel to the wall of the sack, and a granular substance binding these layers together. All the cells bordering the sack, as also those forming the part which is turned outward, participate in the act of secreting the fluid, which hardens to compose the compact body. Hence it is suspended as by two short arms in the opening which leads from the funnel of the oviduct into the curious sack. The compact body must be evacuated before the eggs can pass through the curious sack and the narrow duct, and I think that this is done by the retraction of the margin of the opening which leads from the funnel into the sack. In one of my series of preparations of *Scalpellum vulgare* the opening of the sack is as wide as that of the funnel; the arms of the compact body form a transverse partition between funnel and sack, the remaining part of the compact mass being suspended in the middle of this partition. Regarding the structure of this same apparatus in other genera of Cirripedia I have little to add. In *Lepas anatifera* and *Lepas hillii* the structure of the oviduct is the same as in *Scalpellum*. The funnel at the end of the oviduct where it communicates with the sack seems to be wanting; in a very complete series of preparations of *Lepas hillii* the oviduct can be followed up to where it communicates with the sack. Its structure is very markedly different from that of the sack, so that the place where the one ends and the other begins can easily be seen (Pl. VI. fig. 11). It widens only very inconsiderably to meet the opening of the sack. The wall of the sack is composed of very high and narrow cells (0·05 mm. high and 0·003 mm. wide), having an oval nucleus about half way up. The length of the sack itself in *Lepas hillii* is about 0·8 mm. In *Lepas anatifera* it is a great deal more; in a specimen, the capitulum of which measured 38 mm., the greatest diameter of the sack was 3 mm., the shoe-shaped mass in its interior measuring about 2 mm. I observed the curious sack at the end of the oviduct also in *Balanus corolliformis*, Hoek, and in *Balanus tintinnabulum*, Linné. Its size in the first species is about 0·5 mm.; the way in which the oviduct communicates with the sack in this species is very like that in *Scalpellum*,—the oviduct is considerably swollen at the extremity which meets the sack.

[1] Krohn, *loc. cit.*, p. 361.

[2] Zool. Chall. Exp., part xxv., p. 12.

The sack of *Balanus tintinnabulum* was studied in transverse sections; its diameter was about 0·9 mm. I have been unable to investigate the way in which the oviduct communicates with it.

If Kossmann's explanation as to the presence of the irregular mass in the interior of the curious sack at the end of the oviduct be right (and I have no sufficient ground to doubt its correctness), the function of the cells which form the wall of the sack is to produce a viscous fluid which envelops the eggs. The thick mass which sometimes, and even very often or *as a rule*, is found in the interior of the sack is formed because the secretion continues incessantly, even when no eggs pass through the oviduct. The quantity of this viscous fluid which is secreted by these cells must indeed be rather large; for when a *Lepas* is furnished with ovigerous lamellæ and the interior of its sacks studied, large masses of the secreted substance are present. This must necessarily have been formed after the eggs passed through it, and cannot have been produced very long ago, for in the Cirripedia the evolution of the eggs in general does not take long. The very regular shape of the mass in some genera, as *e.g.*, in *Lepas*, where it is shoe-shaped and has a very smooth surface, must be ascribed to its being modelled, at least in part, after the internal surface of the sack; it remains, however, in my eyes a curious fact which, perhaps, has an analogy in the presence of a chitinous bag within the stomach in this same group of Cirripedia. I observed it in the stomach of all the Cirripedia of which I prepared transverse sections; according to Darwin it is a model of the stomach, filled with excrement and expelled by the rectum entirely in a single piece, as he observed in some living specimens of *Balanus balanoides*.

To understand the physiological meaning of the apparatus at the end of the oviducts, a second difficulty arises from the circumstance that we do not know the place where, and the way in which, the eggs are fecundated. If Kossmann's supposition be correct, the eggs are evacuated after being united together by means of the fluid secreted by the cells of the curious sack. These eggs, however, are ovarian, not yet fecundated eggs! I think it is difficult to understand how they are fecundated after they are united together by a fluid viscous glue. Of course, the only way of investigating successfully physiological questions of this kind is to study fresh and living material. But this study can only give trustworthy results when the anatomical structure is sufficiently well known. I think I have contributed to a more accurate knowledge of the anatomical structure.

I will not take leave of this subject without pointing out the great probability that the apparatus at the end of the oviduct morphologically represents a second segmental organ. Krohn[1] has already shown that, of all Crustaceans, the female genital openings are placed nearest to the cephalic part of the body in the Cirripedia; and even at present, though our knowledge of Crustaceans has been considerably increased since the year 1859, it is still true that they are the only Crustaceans which show this

[1] *Loc. cit.*, p. 360, note at the foot of the page.

peculiarity in their structure. The curious animal which Prof. Lacaze-Duthiers has described as *Laura gerardiæ*, and which according to him belongs to a distinct group of abnormal Cirripedia, has the female genital openings also in the basal segment of the first pair of legs. The peculiar position of these openings in this group would, however, not be so strange, if it could be shown that the female genital apparatus in the case of Cirripedia made use of a segmental organ. Now, I think everybody, who will study preparations of the curious sack and the oviduct in relation to it, will be struck by the totally different structure (1) of the oviduct, (2) of the sack itself, and (3) of the canal or duct, short in *Lepas* and long in *Scalpellum*, at the end of which the genital opening is placed. To call the sack a widened part of the oviduct is not in accordance with the condition of these parts at the place where they are in communication with each other. Even in *Lepas*, where the communication is much more gradual than in *Scalpellum*, the place where the oviduct terminates and the sack commences is very distinct. Since the duct by the aid of which the sack opens is a true epiblastic product, and is lined by a thin chitinous cuticle, the sack, which is placed between it and the oviduct, probably represents the funnel of the original segmental organ. Of course, this suggestion is based on the occurrence of the other pair of segmental organs opening at the base of the second pair of maxillæ, as previously described (p. 23). The first pair of segmental organs furnishes a direct communication of the body-cavity with the surrounding medium, the second serves for the evacuation of the female genital products. The cells of the funnel of the first pair, probably, have an excretory function; those of the second pair have a more special function,—that of producing a viscous fluid for uniting the eggs into egg masses.

I hope I shall soon be able to continue these investigations, and if possible to enlarge them with the aid of fresh material.

PLATE I.

PLATE I.

An. stands for antennæ.
c.gl. ,, cement-glands.
f. ,, muscular fibres.
gs. ,, supræsophageal ganglion.
gt. ,, thoracic ganglion.
gl. ,, gland of unknown nature.
l. ,, thoracic appendages.
m. ,, mouth.

mr. stands for retractor muscle of the thorax.
o. ,, orifice of the sack.
œ. ,, œsophagus.
r. ,, œsophageal ring.
st. ,, stomach.
t. ,, testis.
vd. ,, vas deferens.
vs. ,, vesicula seminalis.

Fig. 1. Male of *Scalpellum regium* (Wyv. Thoms.), Hoek; magnified 94 diameters.

Fig. 2. Nervous and alimentary systems of this male; magnified 275 diameters.

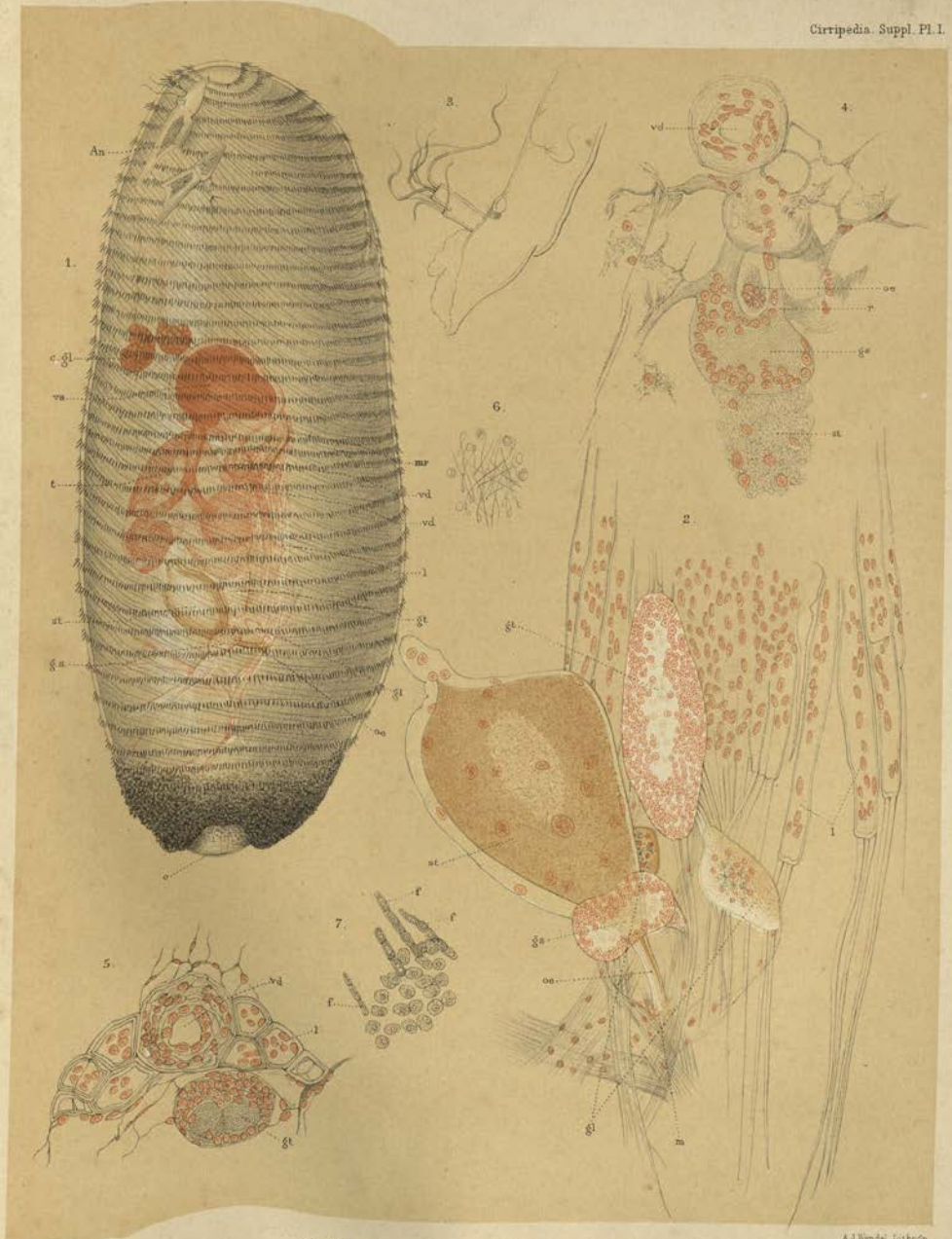
Fig. 3. Antenna of the male; magnified 275 diameters.

Fig. 4. Transverse section of the supræsophageal ganglion where it is in relation with the œsophageal ring; magnified 275 diameters.

Fig. 5. Transverse section of the thoracic ganglion and the thorax with its appendages; magnified 275 diameters.

Fig. 6. Spermatozoa and spermatozoid mother-cells; magnified 575 diameters.

Fig. 7. Epithelium of the sack and muscular fibres in a young stage of development; magnified 275 diameters.



P.P.C. Hoek Del.

MALE OF SCALPELLUM REGIUM.

A.J. Wendel Lithogr.

PLATE II.

PLATE II.

AM. stands for adductor muscle.
An. ,, antennæ.
C. ,, cœca attached to œsophagus.
C I.–C VI. thoracic appendages.
CA. ,, caudal appendage.
C.gl. ,, cement-glands.
E. ,, the large compound eye.
e. ,, the simple eye.
G I.–G VI. thoracic ganglia.
GS. ,, supraœsophageal ganglion.
GT. ,, thoracic ganglion.

Int. stands for intestine.
Inv. ,, invagination dividing the body into a capitulum and peduncle.
M. ,, mouth.
Ma. ,, mantle.
Od. ,, ovarium with oviduct.
Œ. ,, œsophagus.
Op. ,, orifice of the mantle.
Sh. ,, shell.
S or *St.* stomach.

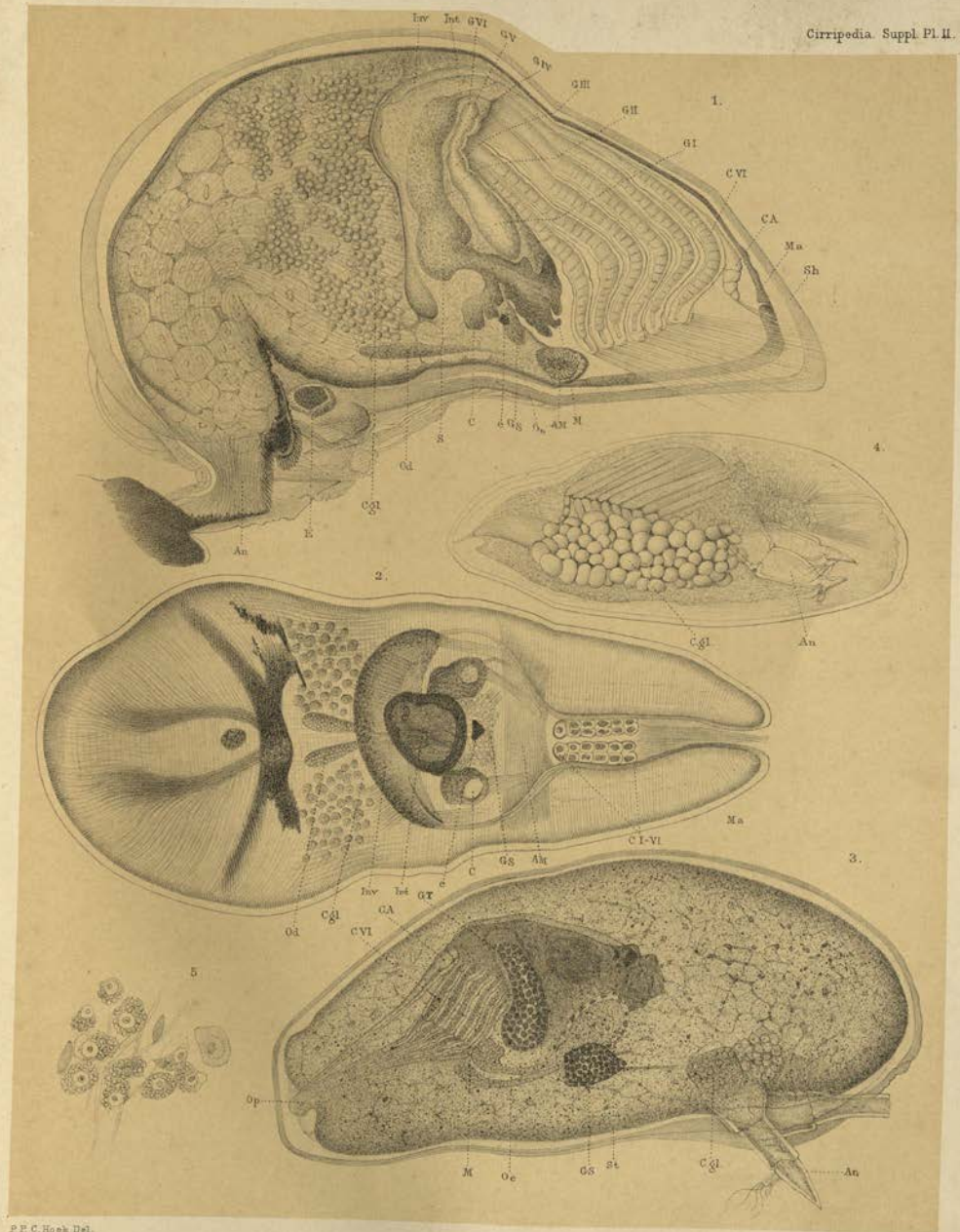
Fig. 1. Cypris-larva of *Lepas australis*, Darwin, sagittal section; magnified 70 diameters.

Fig. 2. Same larva in a slightly older stage, longitudinal section; magnified 70 diameters.

Fig. 3. Cypris-larva of *Scalpellum regium* (Wyv. Thoms.), Hoek, which is destined to develop into a male; magnified 94 diameters.

Fig. 4. Cypris-larva of *Scalpellum triangulare*, Hoek, which is also destined to become a male; magnified 94 diameters.

Fig. 5. Group of cement-cells with their ducts and pale yolk-elements of the Cypris-larva of *Lepas australis*, Darwin; magnified 275 diameters.



P. H. C. Hoek Dgl.

CYPRIS-LARVAE OF CIRRIPEDIA.

A. J. Wendel Lithogr.

PLATE III.

PLATE III.

ca. stands for cavity in which thorax is lodged.
gs. ,, supraœsophageal ganglion.
gt. ,, thoracic ganglion.
in. ,, intestine
l. ,, thoracic appendages.
m. ,, longitudinal muscles of body-wall.
mr. ,, retractor muscle of the thorax.
o. stands for orifice of thoracic cavity.
st. ,, stomach.
t. ,, testis.
th. ,, thorax.
vd. ,, vas deferens.
vs. ,, vesicula seminalis.

Eleven sections out of a series of about eighty through the body of the male of *Scalpellum regium* (Wyv. Thoms.), Hoek.

Fig. 1. First section. Transverse section near the capitular pole.

Fig. 2. Second section. The outer wall is covered by particles of mud; where it is taken away, the nuclei of the chitinogenous epithelium are distinctly visible.

Fig. 3. Third section. To the left the orifice is visible surrounded by a dense mass of cells of the chitinogenous epithelium; to the right the connective tissue is visible with its small nuclei and with the longitudinal muscles of the body-wall.

Fig. 4. One of the following sections, passing transversely through the cavity in which the thorax of the little body is lodged, and which opens outwards by means of the orifice in figs. 1 and 2.

Fig. 5. One of the following sections about the place where the vas deferens opens into the cavity of the foregoing figure.

Fig. 6. Section passing through one of the lobes into which the testis is divided at its capitular extremity, through the stomach, the supraœsophageal ganglion, the thoracic ganglion, the thorax with its central canal, the vas deferens, and the legs.

Fig. 7. In this section both lobes of the testis are represented.

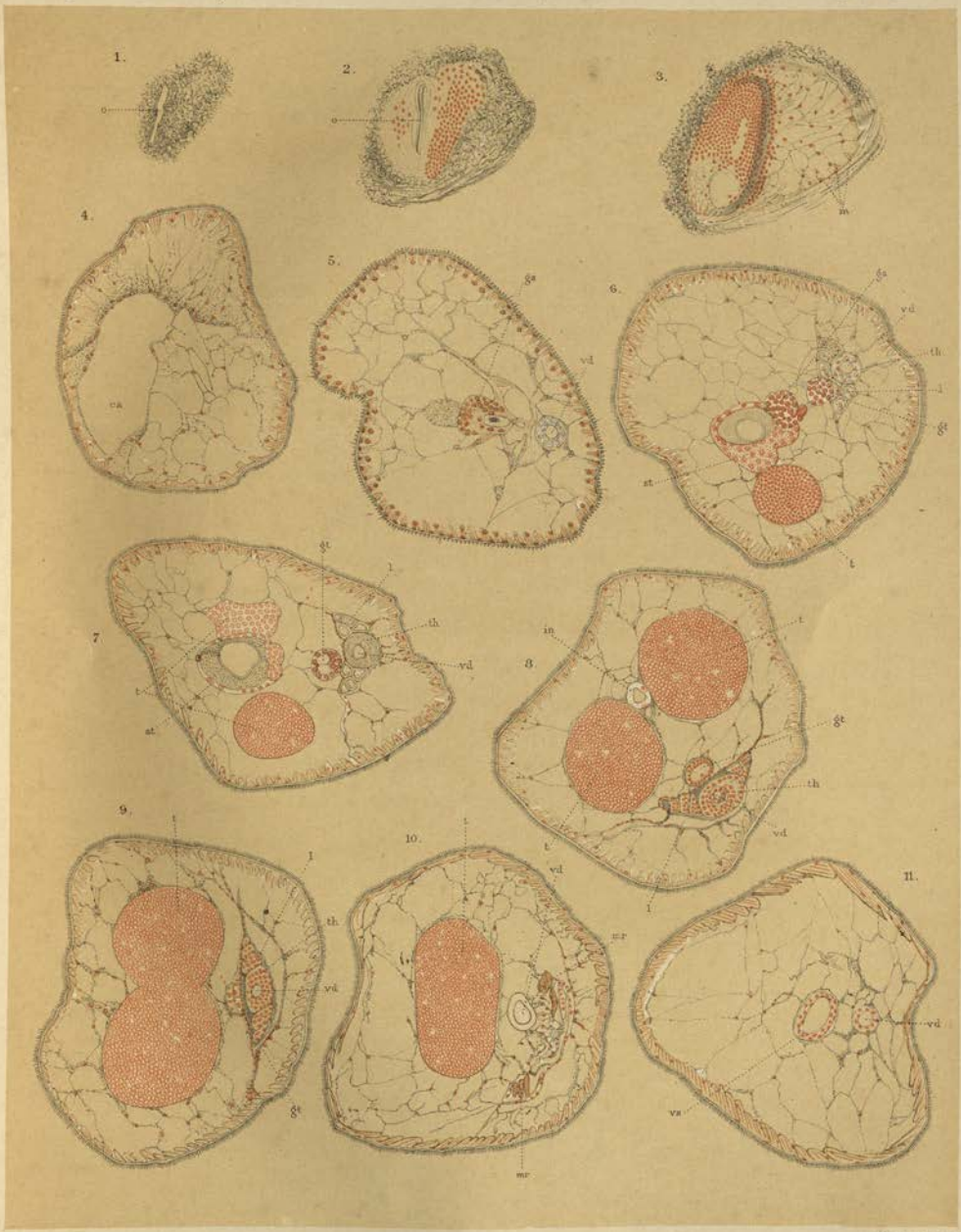
Fig. 8. Between the two sections of the testis the narrow blind sack of the stomach which represents the intestine is visible.

Fig. 9. The two lobes of the testis have united; the thoracic ganglion is only indistinctly represented.

Fig. 10. Section passing through the upper extremity of the thorax.

Fig. 11. Section passing through the vesicula seminalis and vas deferens before the latter enters into the thoracic part of the body.

All the figures magnified 94 diameters.



P.P.C. Hoek Del. A.J. Wendel Lithogr.

MALE OF SCALPELLUM REGIUM.

PLATE IV.

PLATE IV.

an. stands for anus.
c. ,, chitinous wall of the peduncle.
ca. ,, caudal appendages.
cf. ,, connective tissue fibres.
ct. ,, connective tissue nuclei.
cg. ,, cement-glands.
g-g'-g'' ,, first and second thoracic ganglion.
g.a. ,, female genital aperture.
gl. ,, glands of unknown function.
gt. ,, thoracic ganglion.
i. ,, intestine.
mf. stands for muscular fibres.
n. ,, nuclei of the chitinogenous epithelium.
p. ,, penis.
s. or *st.* ,, stomach.
t. ,, testis.
th. ,, thorax.
vd. ,, vas deferens.
vs. ,, vesicula seminalis.
x. ,, widened portions of the oviducts near the genital aperture.
I.-VI. ,, first to sixth cirrus.

Figs. 1–7. Anatomy of the male of *Scalpellum regium* (Wyv. Thoms.), Hoek.

Fig. 1. Transverse section through a male of *Scalpellum regium*, which is in a young stage; stomach filled almost entirely with nutritive yolk.

Fig. 2. Section passing through the vesicula seminalis and a narrow portion of the testis.

Fig. 3. Section passing through a younger male at the level of the cement-glands.

Figs. 1–3 magnified 94 diameters.

Fig. 4. Section through one of the cement-glands; magnified 275 diameters.

Fig. 5. Section of the wall of a male; magnified 575 diameters.

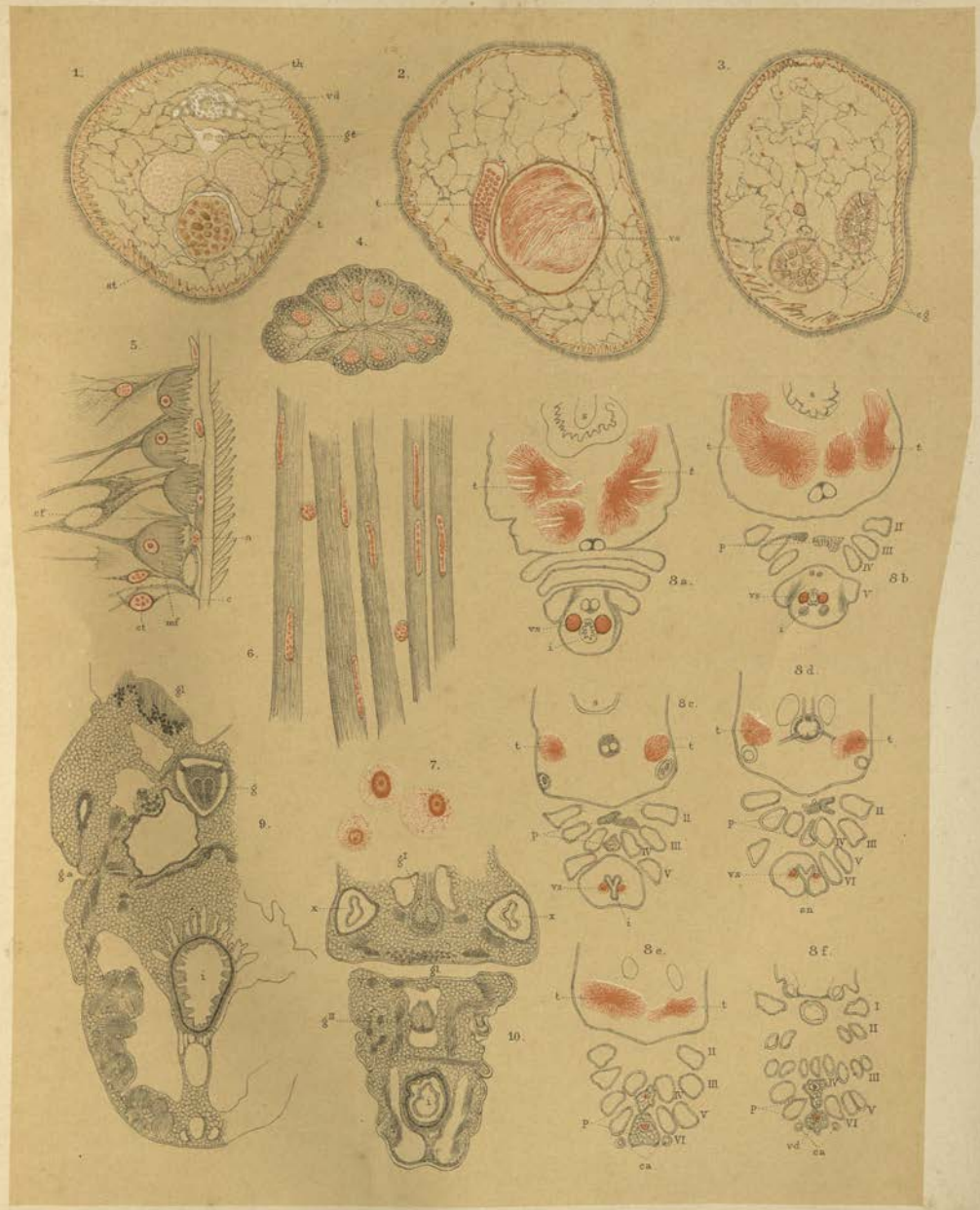
Fig. 6. Muscular fibres; magnified 575 diameters.

Fig. 7. Supposed blood-corpuscles; magnified 575 diameters.

Figs. 8*a*–8*f*. Six out of a series of transverse sections through the body of *Scalpellum calanoides*, Hoek; magnified 41 diameters.

Fig. 9. Part of a section through the body of *Scalpellum parallelogramma*, Hoek, at the base of the first pair of cirri; magnified 26 diameters.

Fig. 10. Part of a section through the body of *Scalpellum nymphocola*, Hoek; magnified 41 diameters.



P.P.C. Hoek. Del. A.J. Wendel. Lithogr.

1-7 MALE OF SC. REGIUM. 8 SC. BALANOIDES. 9 SC. PARALLELOGRAMMA. 10 SC. NYMPHOCOLA.

PLATE

PLATE V.

A. stands for body-cavity.
a. ,, outer layer of (longitudinal) muscles.
B. ,, band of connective tissue.
b. ,, second layer of (circular) muscles.
C. ,, organ of unknown function.
c. ,, inner layer of (longitudinal) muscles.
C.gl. ,, cement-glands.
Ch. ,, chitinous outer wall of peduncle.
D. ,, main cement-duct.
D'–D''' ,, branches of the main cement-duct.
d. ,, initial cement-ducts.
e. stands for darkly pigmented epithelium.
in. ,, intestine.
M. ,, outer maxilla.
m. ,, muscle masses.
n. ,, nerve cords.
O. ,, ovarian cœca.
od. or *Od.* oviduct.
t. stands for testis.
s. ,, segmental organ.
Sd. ,, segmental duct.
x. ,, (elastic) fibres of the connective tissue.

Figs. 1–3. Segmental organ of *Scalpellum vulgare*, Leach.

Fig. 1. Transverse section of the body of *Scalpellum vulgare*, Leach, about the second pair of maxillæ; magnified 27 diameters. The band of connective tissue (B) contains cœca of the testis.

Fig. 2. Section of the segmental funnel; magnified 305 diameters.

Fig. 3. Section of the segmental organ; magnified 106 diameters.

Figs. 4, 5. Anatomy of the peduncle of *Lepas anatifera*, Linn.

Fig. 4. Transverse section near the upper extremity; magnified $8\frac{1}{2}$ diameters.

Fig. 5. Part of a section near the upper extremity; magnified 58 diameters.

Figs. 6, 7. Anatomy of the peduncle of *Scalpellum vulgare*, Leach.

Fig. 6. Part of a section at about 5 mm. from the upper extremity; magnified 33 diameters. The chitinous outer wall with the scales removed.

Fig. 6*. One of the cement-glands; magnified 192 diameters.

Fig. 7. Part of a section near the lower extremity; magnified 33 diameters.

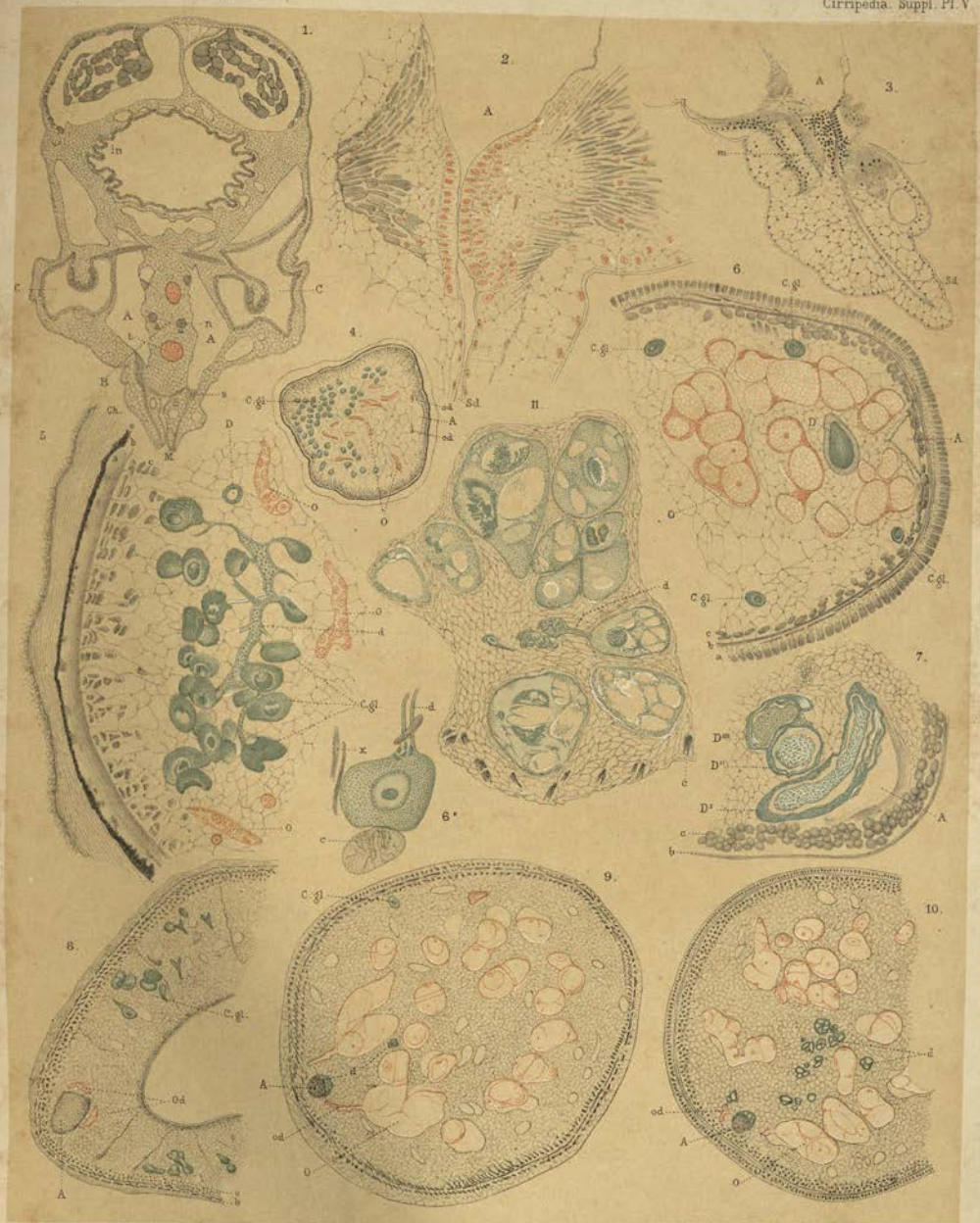
Figs. 8–11. Anatomy of the peduncle of *Scalpellum regium* (Wyv. Thoms.), Hoek. (The chitinous outer wall with the scales removed.)

Fig. 8. Part of a section near the upper extremity; magnified $8\frac{1}{2}$ diameters.

Fig. 9. Section at about 1 cm. from the upper extremity; magnified $8\frac{1}{2}$ diameters.

Fig. 10. Section about half the length of the peduncle; magnified $8\frac{1}{2}$ diameters.

Fig. 11. Group of cement-glands in the upper extremity of the peduncle; magnified 58 diameters.



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A.J. Wendel Lithogr.

1-3 SCALPELLUM VULGARE. 4-5 LEPAS ANATIFERA. 6-7 SC. VULGARE. 8-11 SC. REGIUM.

PLATE VI.

PLATE VI.

A. (in fig. 1) stands for matured ovum.
A. (in fig. 3) ,, body-cavity.
A. (in fig. 6) ,, musculus adductor scutorum.
B. stands for ovum, not fully matured.
C. (in fig. 1) stands for young ovarian eggs.
C. (in fig. 10) ,, outer sack of connective tissue.
c. stands for inner layer of longitudinal muscular fibres.
D. ,, genital duct.
d. (in fig. 1) stands for epithelium of ovarian wall.
d. (in fig. 3) ,, cement-ducts.
gl. stands for pancreatic gland.
GS. or *G.* supracesophageal ganglia.
GA. ,, genital aperture.
L. ,, labrum.
l. ,, cœca of the so-called liver.
M. ,, mouth.
O. stands for ovarian cœca.
oc. ,, eye.
Od. or *ov.* oviduct.
Oe. ,, œsophagus.
o.n. ,, four optic nerves.
P. ,, pancreatic gland.
p.n. ,, peduncular nerve.
S. (in figs. 4 and 6) stands for stomach.
S. (in fig. 10) stands for funnel at the end of the oviduct.
S'. stands for curious sack.
t. ,, testicular cœca.
W. ,, body-wall.
X. (in fig. 2) stands for yolk-elements of egg.
X. (in figs. 10 and 11) stands for unknown mass.
I.–III. stands for small optical ganglia.

Fig. 1. Part of one of the cœca of the ovarium of *Scalpellum vulgare*, Leach; magnified 685 diameters.

Fig. 2. Nucleus with nucleolus of a nearly ripe ovarian egg of *Scalpellum vulgare*, Leach; magnified 685 diameters.

Fig. 3. Part of a section of the peduncle of *Scalpellum regium* (Wyv. Thoms.), Hoek, in its lower half; magnified 33 diameters. Body-cavity, acting as the main cement-duct.

Figs. 4, 5. Pancreatic gland of *Scalpellum parallelogramma*, Hoek.

Fig. 4. Part of a transverse section through the cephalic part of the body; magnified 33 diameters.

Fig. 5. Section of the gland where it has its greatest diameter; magnified 106 diameters.

Fig. 6–9. Anatomy of *Lepas anatifera*, Linné.

Fig. 6. Sagittal section of the body; magnified 1·5 diameters.

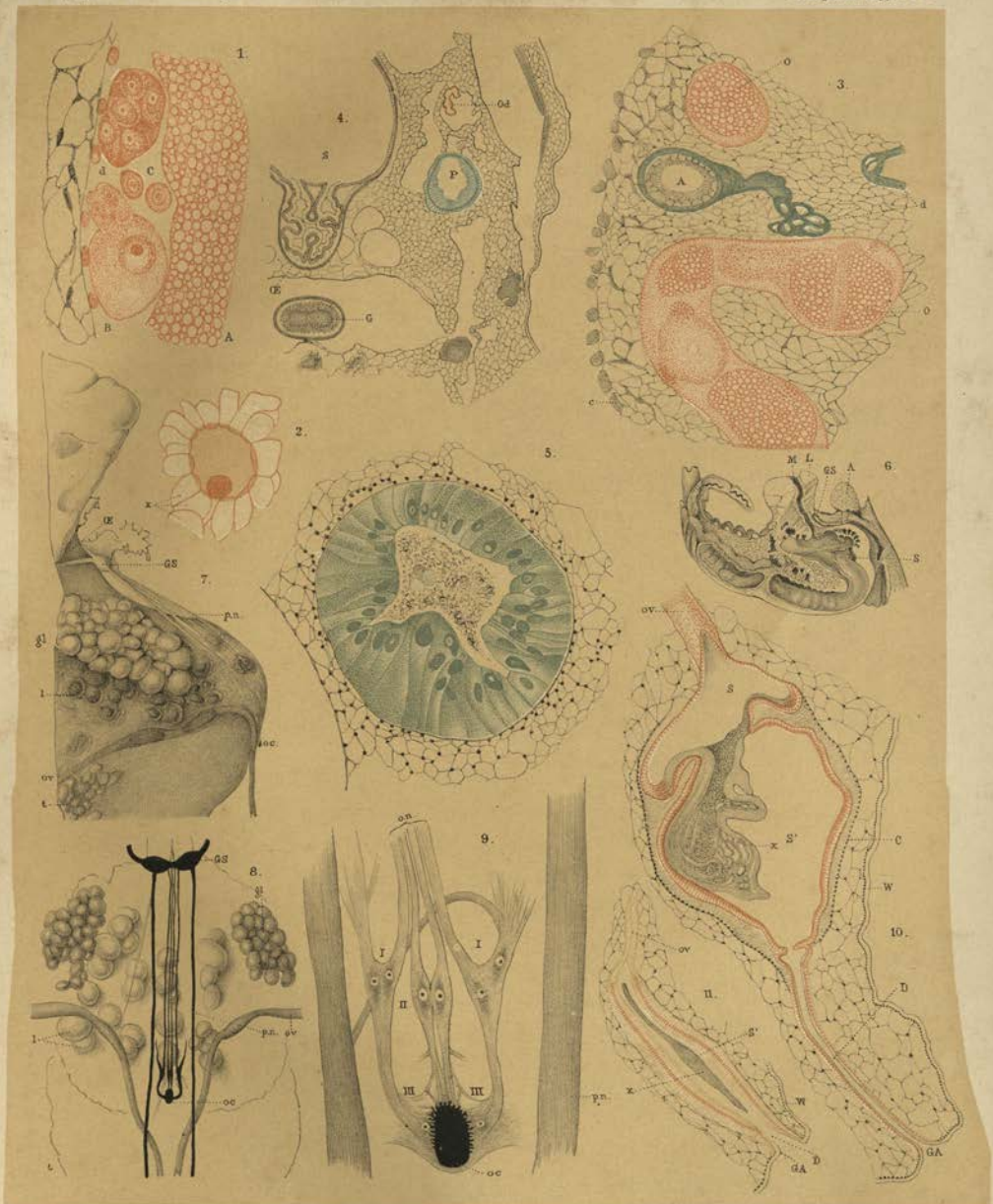
Fig. 7. Lateral view of the upper and front part of the stomach, after the muscles have been removed; magnified 8 diameters.

Fig. 8. Frontal view of a part of the stomach with the supracesophageal ganglia; magnified 8 diameters.

Fig. 9. The eye and its innervation; magnified 58 diameters.

Fig. 10. The apparatus by means of which the oviduct opens in *Scalpellum vulgare*, Leach; magnified 106 diameters.

Fig. 11. Same apparatus of *Lepas hillii*, Leach; magnified 58 diameters.



P.P.C. Hoek. Del.

A.J. Wendel Lithogr.

1-2 SCALPELLUM VULGARE. 3 SC. REGIUM. 4-5 SC. PARALLELOGRAMMA.
6-9 LEPAS ANATIFERA. 10 SC. VULGARE. 11 LEP. HILLII.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the HUMAN CRANIA AND OTHER BONES OF THE SKELETONS collected during the Voyage of H.M.S. Challenger, in the years 1873–1876. By WILLIAM TURNER, M.B., LL.D., F.R.SS. L. & E., Professor of Anatomy in the University of Edinburgh, Foreign Member of the Anthropological Society of Paris.

PART I.—THE CRANIA.

DURING the voyage of H.M.S. Challenger Human Crania and Skeletons were collected at several of the ports at which the ship called. These were entrusted to me by Sir C. Wyville Thomson on the return of the expedition. They consisted of specimens from the following localities:—

The Admiralty Islands,
Hawaii, Sandwich Islands,
Oahu, Sandwich Islands,
Chatham Islands,
New Zealand,
Australia,
Tierra del Fuego,
Patagonia,
Bush Race, from South Africa.

In this part the Crania only are described. The other bones will form the subject of a short second part in a subsequent volume.

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HUMAN CRANIA.

INTRODUCTION.

In the description of these crania I have to a large extent adopted the terms and craniometrical methods introduced by the late M. Paul Broca, which have contributed so much to give exactness to craniological research. It is not necessary that I should enter here into any detailed explanation of the meaning of the terms which he has proposed with so much advantage. For not only are they amply defined in his own writings, more especially in his well-known Instructions Craniologiques et Craniometriques,[1] but a sufficient explanation of them is furnished to all English readers in the translation of Dr. Topinard's Anthropologie,[2] and in Prof. Flower's Catalogue of the Human Crania in the Museum of the Royal College of Surgeons of England.[3]

It will, however, be advisable to say a few words about some of the craniometrical methods which I have employed. For unfortunately there are in use by craniologists so many different ways of measuring even the principal dimensions of the skull, that it becomes necessary for each investigator to preface his description by stating the method that he has himself pursued.

As it is important in all craniological enquiries to obtain an average from as large a number of specimens as possible, I have not restricted myself to the examination and mensuration of the skulls collected during the voyage of the Challenger; but have, whenever practicable, studied along with them skulls from the same localities, preserved either in the Edinburgh University Anatomical Museum or in other collections in this city. This Report has therefore become an essay on the craniology of certain Races of Men.

The measurements have been made with instruments supplied by M. Mathieu of Paris. They are recorded in millimètres. In calculating the indices when the fraction was below ·5 I have not taken it into account. When ·5 or above ·5, I have either stated it or given the benefit of the fraction to the preceding whole number.

In each table of measurements I have recorded the length both from the most projecting mid-occipital point to the ophryon, and from the mid-occipital point to the most prominent part of the glabella. I have not thought it necessary specially to record

[1] Paris, 1875.

[2] Translated by Dr. R. T. H. Bartley. Library of Contemporary Science, London, 1878.

[3] London, 1879.

the diameter from the mid-occipital point to the fronto-nasal suture (nasion), which is the dimension taken by Professors van der Hoeven,[1] Cleland[2] and Virchow,[3] for I find that as a rule it approximates to the ophryo-occipital diameter. In many specimens, more especially in female skulls, the difference between the ophryo-occipital, nasio-occipital and glabello-occipital diameters, does not amount to more than two or three millimètres, and it is only when a great development of the frontal air-sinuses and of the glabella takes place, that the difference in these three diameters becomes very distinctly marked.

The greatest breadth recorded in the table is taken in the parietal or parieto-squamous region, wherever it occurs, and the letters *p* and *s* appended to the measurement express whether this maximum breadth be situated at or near the parietal eminence, or at or near the parieto-squamous suture. The greatest breadth and the glabello-occipital diameter have been taken therefore in the manner proposed by the illustrious Retzius,[4] the founder of scientific craniometry.

The length-breadth or cephalic-index has been calculated from the relations between the greatest breadth and the glabello-occipital length,[5] but those craniologists who desire to take the ophryo-occipital length as the basis of their calculation have the data furnished in the tables. I have preferred the glabello-occipital length as a basis for calculating the cephalic index, rather than the ophryo-occipital diameter, which has been adopted by Dr. Barnard Davis[6] and by Professors Rolleston[7] and Flower.[8] For the ophryon has not the same definite position as the glabella, and observers do not always agree in localising the ophryon at the same point on a skull. To ignore the glabella in estimating the extreme length of the cranium, is to leave out of consideration an eminence which in many skulls and heads constitutes one of the most noticeable features in the frontal region, and which is so frequently an important sexual character. Moreover, it seems to me that with the skull as with the living head, our object should be to compare the greatest length and greatest breadth with each other wherever they occur, and not to confine our measurements to those parts of the skull which more directly form the wall of the brain cavity.

I have arranged the crania according to the proportions of length and breadth into three categories and have adopted M. Broca's term mesaticephalic, to express a group between the dolichocephalic and brachycephalic types of skull.

I have not thought it necessary to adopt those minor subdivisions of sub-dolichocephalic

[1] Catalogus craniorum diversarium gentium, Leyden, 1860.

[2] Variations of the human skull, &c., *Phil. Trans.*, 1869.

[3] *Archiv für Anthropologie*, vol. iv. p. 59, 1870.

[4] Müllers *Archiv*, 1845, p. 126, and Ethnologische Schriften, pp. 24–166.

[5] The glabello-occipital length is merely another mode of expressing the diameter subsequently named by M. Broca, the antero-posterior maximum.

[6] Although Dr. Davis states that his measurement is taken from the glabella, yet as he regards that "as about an inch above the fronto-nasal suture," it obviously approximates closely to the ophryon.

[7] British Barrows, p. 560, 1877, and collected Scientific Papers and Addresses edited by Prof. Turner, p. 165, Oxford, 1884.

[8] Catalogue of Human Crania, p. xvii. 1879.

and sub-brachycephalic which M. Broca,[1] and Dr. Thurnam,[2] have employed, or a somewhat similar series of terms suggested by Prof. Huxley;[3] for, however interesting such subdivisions may be in recording the indices of individual skulls, they are really of little practical value in expressing differences of race; and by giving an appearance of minute accuracy under conditions which are variable within certain limits, they are apt to give an importance to groups, the numerical limits of which are quite arbitrary, greater than they actually possess. The numbers which I have employed to mark the limits of each of the three groups are similar to those used by Prof. Flower:—*e.g.*, Dolichocephalic, below 75; Mesaticephalic, 75 to 80; Brachycephalic, above 80.

The vertical or altitudinal index has been calculated from the relations between the basi-bregmatic height and the glabello-occipital length. It is, therefore, an expression of the relation of length to height. Data for calculating the relation of breadth to height and of forming therefore a breadth-height index, are provided in the tables. The terms platycephalic or tapeinocephalic have been suggested by various craniologists, to indicate skulls with a low vertical index, and akrocephalic or hypsicephalic[4] to express those whose index is high. For skulls of intermediate or moderate altitude I have used the term metriocephalic. The following classification of skulls in accordance with the relations of length and height is adopted in this Report:—Tapeinocephalic, below 72; Metriocephalic, between 72 and 77; Akrocephalic, above 77.[5]

The minimum frontal, stephanic, and asterionic diameters have been taken according to the methods prescribed by M. Broca. In many instances, though not in all, the stephanic diameter gives the greatest diameter in the region of the frontal bone.

The horizontal circumference has been obtained with a graduated tape line, by measuring from the most projecting part of the glabella around the occipital point back to the glabella. The total longitudinal arc is the distance in a curved line from the nasion over the vertex, to the opisthion, and the proportions contributed to this arc by the frontal, parietal, and occipital bones respectively, are also stated. The vertical transverse arc is measured from the supra-auricular point over the bregma to the corresponding

[1] *Bulletins de la Société d'Anthropologie*, t. i. p. 507, 1861; La classification et la nomenclature craniologiques in *Revue d'Anthropologie*, t. i. p. 385, 1872.

[2] Ancient British and Gaulish Skulls, *Memoirs of the Anthropological Society of London*, vol. i. 1865.

[3] Prehistoric Remains of Caithness, p. 85, 1866.

[4] M. M. de Quatrefages and Hamy (Crania Ethnica, *passim*) call a skull hypsistenocephalic when the vertical index is higher than the cephalic index.

[5] In a recent number of the *Archiv für Anthropologie*, Bd. xv., 1st and 2nd Vierteljahrsheft, 1884, published after the above Report was in type, Professors Kollmann, Ranke and Virchow in recommending certain terms and methods to be employed by craniologists suggest the following to express the altitudinal index; Chamæcephalic (flat skulls) up to 70·0; Orthocephalic from 70·1 to 75·0; Hypsicephalic (high skulls) 75·1 and upwards. The term metriocephalic, which I have suggested in the text is, I would submit, to be preferred to that of orthocephalic, because it expresses like the well known terms mesaticephalic and mesocephalic, a form intermediate between two extremes (*μέτριος* moderate), whilst the word *ὀρθός* has no special relation to this intermediate index. Besides the term orthocephalic had previously been used by Prof. Welcker to express the *breadth* index of a group of skulls intermediate between the dolichocephalic and brachycephalic.

point on the opposite side. I have not thought it necessary to give the inferior measurement below the base of the skull between the two supra-auricular points.

I have determined the relative projection of the zygomatic arches as compared with the transverse diameter of the cranium, by placing the skull, without the lower jaw, on a low table, resting it on the teeth and the most depending parts behind. Then, standing erect, I have looked down on the vertex with the right eye directed to the bregma and with the left closed. The terms phænozygous and cryptozygous employed by Mr. Busk have been used to express whether, from this point of view, the zygomata were visible or invisible.

The basi-nasal and basi-alveolar diameters have been taken from the basion, in the one case to the nasion, in the other to the alveolar point, and the gnathic index has been calculated from the $\frac{\text{basi-alveolar length} \times 100}{\text{basi-nasal length}}$. The classification employed by Flower into Orthognathous below 98; Mesognathous from 98 to 103; Prognathous above 103 has been adopted. The basion has therefore been taken as an important central point for determining the length in a straight line from it to the alveolar point, the nasion, and the bregma.

The length of the foramen magnum from basion to opisthion is given. This measurement, along with the basi-nasal length, and the longitudinal arc, also recorded in the tables, will enable the entire circumference of the cranial box mesially and antero-posteriorly to be computed.

The interzygomatic breadth is the distance between the most projecting parts of the zygomatic arches. The intermalar breadth has been taken on a line with the hinder border of the orbital process. The ophryo-alveolar length is measured from the ophryon to the alveolar point, and the naso-alveolar length from the nasion to the same point. The facial index expresses, according to the method of Broca, the relations of the inter-zygomatic breadth to the ophryo-alveolar length, and is arrived at by the following formula: $\frac{\text{Ophryo-alveolar length} \times 100}{\text{Bizygomatic diameter}}$. I do not attach much importance to a facial index based upon the ophryo-alveolar length; partly on account of the imperfect definition of the ophryon, and partly because the lower jaw is left out of consideration in the determination of the length of the face. The nasal and orbital measurements, with their respective indices, have been taken according to the methods of M. Broca, and the classification employed by Broca and by Flower has been adopted: *e.g.*, Nasal index, Leptorhine, below 48; Mesorhine, from 48 to 53; Platyrhine, above 53: Orbital index, Microseme, below 84; Mesoseme, from 84 to 89; Megaseme, above 89.

Professor Broca also estimated[1] the dimensions of the hard palate without including the dentary arcade. Professor Flower modified and improved these measurements by

[1] Instructions Craniologiques, p. 77.

including the dentary arcade along with the hard palate.[1] He makes the length of the palate to extend from the alveolar point to a line drawn across the hinder borders of the maxillary bones, and its width between the outer borders of the alveolar arch immediately above the middle of the second molar tooth. Instead, however, of using the terms maxillary length, width, and index, which Professor Flower employs, I prefer to call these measurements palato-maxillary[2] or palato-alveolar, as expressing more precisely their nature. As considerable differences exist in the relative length and breadth of the palato-maxillaries in different individuals, it is advisable to have descriptive terms to express the different value of the palato-maxillary index. To follow the rule pursued by craniologists, terms compounded of Greek words should be employed. As οὐρανὸς signifies the vault or roof of the mouth, the term Dolichuranic would indicate a palato-alveolar region where the length is to the breadth proportionally great, so that the roof of the mouth is elongated, and Brachyuranic would express the opposite condition, in which the roof of the mouth approaches more to the semi-circular in form; whilst Mesuranic would of course indicate a region intermediate in its proportions. The Latin terms longi-palatal, brevi-palatal, and medio-palatal would be equally appropriate. The following classification, based on differences in the palato-alveolar region, has been introduced into the Report:—Dolichuranic, index below 110; Mesuranic, between 110 and 115; Brachyuranic above 115.

The measurements of the lower jaw scarcely require any explanation, but I may state that the breadth of the ascending ramus is its antero-posterior diameter on a line with the alveolar border.

In determining the age of a skull, I have relied on the condition of the sutures and on the dentition. When the sutures of the cranial vault were ossified, both in the inner and outer tables, and when the teeth were either much worn down or shed, and the sockets absorbed, the skull is then said to be "aged." When the teeth were all erupted, except perhaps one or two of the wisdoms, and either slightly or moderately worn, and the sutures either unossified or only partially obliterated, the skull is called "adult." The age of the skull in childhood and youth has been arrived at by observation of the state of the milk and permanent dentition.

In determining the sex I have relied, in the comparison of the skulls of each race, on the greater size, weight and capacity, on the projection of the glabella, supraciliary ridges, mastoid processes, inion, and superior curved occipital line, and on a more backward slope of the frontal region as characteristic of male skulls. Whilst a more feeble development of the ridges and projections which mark the position of air-sinuses and attachment of muscles; smaller size and capacity; a fuller occipital squama as compared with the inion

[1] Cranial characters of natives of Fiji Islands, *Journ. of Anthrop. Inst.*, Nov. 1880.

[2] See abstract of my communication on the Crania of the Admiralty Islanders, *Trans. International Medical Congress*, vol. i. p. 146, 1881, and in *Journ. Anat. and Phys.*, vol. xvi. p. 135.

and curved line; a more vertical forehead, a greater flattening of the vertex and consequently a diminished height of the skull, with frequently, though not invariably, a greater breadth of the cranium in the region of the parietal eminences than near the squamous suture, have been regarded as characteristic of female skulls.[1]

A careful enquiry into these different characters will, without much difficulty, enable the craniologist to pronounce definitely as to the sex of a large proportion of the human crania which may be submitted to him for examination. But in large collections of skulls there are always specimens the characters of which are not sufficiently pronounced to enable one to state with certainty to which sex they had belonged. Various specimens of this kind have been distinguished in the tables which accompany this memoir by a query.

In determining several of the indices I have in many instances been saved the labour of calculation by employing the very useful tables which Professor Flower has appended to his catalogue of the human crania in the Museum of the Royal College of Surgeons of England.[2]

The determination of the internal or cubic capacity of the cranial cavity, so as to ensure accuracy and uniformity in result is admittedly one of the most difficult measurements to be undertaken by the craniographer. The amount of shot, or sand, or glass beads, or seeds of different kinds which a skull can contain varies, as has been pointed out, especially by M. Broca,[3] Dr. Wyman,[4] M. Topinard,[5] and Dr. E. Schmidt,[6] with the size of the particles, with the dimensions of the funnel through which they are poured into the cranial cavity, with the rapidity of their flow, and with the extent to which the skull is shaken and the particles made to subside and be compacted together. In a similar manner, the estimation of the amount of the material poured into a skull varies with the height of the cubic measure, with the rate at which the substance is poured into the measure, and with the amount of succussion to which it is subjected. M. Broca strove to give uniformity to the guaging and cubage of a skull by always employing shot of a definite size (No. 8), by pouring it through a funnel, the neck of which had a narrow diameter, and by ramming the shot when in the skull so as to ensure the closest possible approximation of the particles. The shot was then emptied from the skull into measures of a definite height, with the aid of a funnel having a neck of a particular diameter.

[1] M. Broca's Instructions Craniologiques, already cited, and Prof. Ecker's article in *Archiv für Anthropologie*, Bd. i. p. 83, may be consulted with great advantage on the sexual characters of crania.

[2] Professor Welcker has also given in the *Archiv für Anthropologie*, Bd. iii. Heft 3, excellent tables for the determination of the indices of breadth and height.

[3] *Mém. de la Soc. d'Anthropologie de Paris*, sér. 2, t. i. p. 63, 1872, also t. ii. p. 1; and Instructions Craniologiques.

[4] Observations on Crania, *Proc. Boston Soc. Nat. Hist.*, vol. xi., April, 1868.

[5] Anthropology, English translation, p. 226, and more fully in *Revue d'Anthropologie*, t. v. p. 385, 1882. I wish to express my obligations to M. Paul Topinard for the interesting demonstration which he gave me of the mode of using M. Broca's method for obtaining the cubic capacity and the precautions which it is necessary to employ in order to avoid error.

[6] *Archiv für Anthropologie*, Bd. xiii. p. 53, 1882.

In this way uniform results can undoubtedly be arrived at, but as is now admitted the cubage so obtained gives a higher numerical value to the contents than is the actual capacity of the cranium as tested by the employment of water for the purposes of cubage. This is not to be wondered at when it is remembered that the shot is rammed into the cranial cavity to its utmost capacity, whilst no corresponding pressure is applied to the shot after pouring it into the cubic measure, so that necessarily it occupies a greater space in the measure than in the skull. Dr. E. Schmidt, whilst recognising that Broca's method is not only the most practicable, but also the most precise of all the methods up to that time employed, has yet found it necessary to draw up tables by means of which the measurements taken according to Broca may be reduced to the actual capacity. Thus when shot is employed, whilst Broca's method would give 1000 cubic centimetres, the actual capacity is 931, making a difference of 69, and the difference gradually rises until a capacity of 1500 (Broca) is only 1409 (Schmidt), and one of 2000 (Broca) is 1887 (Schmidt), the difference between the apparent and real capacities in the last example being as much as 113 cc.

What is undoubtedly a desideratum in the determination of the cranial capacity is a method which will bring the two processes of guaging the skull and cubing its contents into precisely uniform conditions, so that the number obtained in the cubage may express the actual capacity. I have performed a number of experiments with this object, and have now elaborated a method which gives results so nearly uniform when tested with a standard skull, that it may, I think, be taken as furnishing in each case a close approximation to the actual capacity. This standard skull was itself prepared by stopping all the foramina, except the foramen magnum, with cement and by coating both the inner and outer tables with sealing wax varnish. The method is based upon two of the most important principles insisted on by Broca, viz., that the size of the particles employed must be uniform, and that they should be poured into the skull through a funnel, the neck of which has a definite diameter.

No. 8 chilled shot has been employed as, from its hardness, it preserves its globular form much more efficiently than ordinary shot.[1] A litre is filled with this shot, which is then poured into the foramen magnum through a funnel 14·5 centimetres wide at the mouth, and 12·5 cm. in depth, the spout of which is 2 cm. long and 2 cm. wide. The skull is then lifted in both hands and a sharp tilt forwards given to it so as to project the shot into the anterior and middle cranial fossæ. Shot is again poured in through the same funnel until it reaches the foramen magnum, care being taken that it shall pass well down into the occipital region. The skull is again lifted and a sharp tilt given, first

[1] I attach importance to the preservation of the globular form of the shot, as it thereby runs much more uniformly than if the particles were flattened or irregularly shaped. An objection to the method of ramming the shot employed by Broca is the constant change of form which the particles are made to undergo, and the alteration therefore in the number of their surfaces of contact.

to the right and then to the left. More shot is then poured through the funnel until it reaches the foramen, when the thumb is placed on the shot and pressed into the cavity downwards and backwards; the measure of resistance offered to the thumb expresses whether in the previous operation the cranial cavity has been properly filled. Shot is again poured through the funnel until the skull is filled to the foramen magnum. It will be observed that I do not ram the shot in the process of guaging, and do not therefore overfill the cavity.

In cubing the contents the shot is not poured into a litre and a demi-litre measure, as was the practice of M. Broca, but through the same funnel as that used in filling the skull into the large 2 litre glass cylinder graduated in intervals of ten centimetres, devised by Prof. Ranke of Munich, and for a gift of which I am greatly indebted to that eminent anthropologist.[1] Each skull was gauged and cubed at least twice, once by myself, and once by my museum assistant Mr. James Simpson. The figures stated in the tables are the mean of the two measurements, and in no case was a measurement accepted where a difference occurred of more than 10 cubic centimetres. When such a difference arose, as occasionally took place from inadvertence in not attending to some of the necessary precautions, the skull was at once remeasured. I have arranged the skulls according to their capacities into three divisions, and have employed the same numerical classification as Prof. Flower; viz.: Microcephalic below 1350; Mesocephalic between 1350 and 1450; Megacephalic above 1450 cubic centimetres.

BUSH RACE, SOUTH AFRICA.

Plates I., VI. Tables I., XVIII., XIX.

Two crania, both apparently males, were collected by the Challenger Expedition. In the same box were the pelvic bones and long bones of the limbs of one skeleton, but these were unfortunately so much injured that exact measurements could not be taken. No memorandum of the donor of these skulls has been preserved, but Mr. Murray thinks that they were presented by the late Dr. Bleek. Along with them were several stone implements shaped into lance heads, a large perforated stone ball, some fragments of pottery and two Ostrich eggs. I have examined along with these specimens five other Bush crania,[2] one of which was a child of about nine years, and the remarks which follow

[1] Prof. Ranke has since devised a reproduction of a skull in bronze, in which all the inequalities of the cranial cavity are reproduced, and which, from the imperviousness of its walls, both to water and mercury, enables either of these agents to be employed so as to obtain a definite standard of comparison. Prof. Ranke brought this bronze skull under the notice of the Deutsche Gesellschaft für Anthropologie, October 1882. See the Correspondenz Blatt, p. 137, in *Archiv für Anthropologie*, Bd. xv., 1884.

[2] One specimen was purchased for the University Anatomical Museum many years ago; a second, being the one figured in Plate I., was presented along with the skeleton by Dr. P. C. Sutherland and W. Proudfoot, Esq., of Natal. This man came from the mountains at the source of the Umzimkulu and St. John's river. He had been about twelve years

are based on the investigation of seven skulls. The six adult crania were with one exception probably all males.

Norma verticalis.—Crania elongated antero-posteriorly. Parietal eminences usually well marked, and placed near the back of the side of the skull. Frontal eminences distinct. Skull somewhat flattened on summit. No median ridge in sagittal region. Cryptozygous except in two specimens, in which the zygomatic arches were just visible. The stephanic diameter was in three specimens less than, in two equal to, and in two greater than, the asterionic.

Norma lateralis.—All the skulls rested behind on the cerebellar part of the occipital bone. In only one was there much projection of either the glabella or supraciliary ridges. In all the frontal bone ascended almost vertically from the glabella, and the frontal region of that bone passed somewhat abruptly into the coronal region. In three specimens a median ridge marked the position of the obliterated frontal suture. The tendency to flattening of the vault gave a low curve to the vertex. There was no marked flattening in the region of the obelion and upper occipital squama, such as would have been produced by artificial pressure. The squama projected behind the occipital protuberance. The frontal longitudinal arc was in each skull markedly greater than the occipital; in four specimens it was greater than the parietal; whilst the parietal was in five skulls greater than the occipital.

The nasal bones were not strongly developed; they never exceeded 25 mm. in length, and 7 mm. in breadth; not unfrequently they were partially fused together. The bridge of the nose was so flattened that the nasals formed almost a plane surface between the nasal processes of the superior maxillaries, and there was, with one exception, scarcely any depression at the naso-frontal suture. The nasal spine of the superior maxillæ was feeble. The junction of the side walls with the floor of the anterior nares was rounded. In five of the crania there was a marked depression in the frontal, immediately above the external angular process, which gave great prominence to that process. In five crania the infra-orbital and canine fossæ were deep, in two shallow. The infra-orbital part of the malar bones projected forwards and approximated to the plane of the lower border of the nasals, so that the face in the fronto-naso-orbital region was flattened. The interzygomatic breadth invariably exceeded the intermalar, stephanic or asterionic, but was considerably less than the interparietal breadth. The intermalar was in three cases greater than the stephanic, once equal to and twice somewhat less than it. The face

with Mr. Proudfoot, and died of phthisis. Two were presented by one of my pupils, Mr. W. J. van der Merwe. They were from his father's estate of Drift, Calvinia district. One was a male somewhat advanced in years, the other a child about nine. The adult skull which I believe to be female was lent to me in November 1883, by Adam Sedgwick, Esq., of Trinity College, Cambridge, to whom it was given by Dr. Theophilus Hahn, the Colonial Philologist. It came from Uitenhag in the eastern district. Although I did not receive this skull until after the bulk of the Report was in type, I have been able to include it in the table of measurements, and to incorporate its characters in the text.

was broad and flattened in the norma facialis. The mean interorbital breadth was 23·5 mm.; the maximum 27 mm.; the minimum 21 mm.

The teeth were fully erupted in five crania, and in the adult from Drift, Calvinia, the sockets of the lower molars and upper incisors and canines were absorbed. In one skull the upper wisdoms were only partially erupted, and in the child's skull the dentition marked the 8th or 9th year. Except in the child and one of the adults the teeth were much worn, even in the skull with imperfectly cut wisdoms, but there was no decay.

The cranial sutures in B were simple in their denticulations, the sagittal immediately in front of the obelion was deflected to the right, and small Wormian bones were in the lambdoidal suture. In the other skulls the sutures were more deeply denticulated, and small Wormian bones were not unfrequent in the lambdoidal suture. In three the sutures were in course of senile obliteration. No skull was metopic, and the temporal squama did not articulate with the frontal. The temporal ridges were not strong.

In two crania the ossa plana of the ethmoid were small. In one of these on both sides, and in the other on the right side only, the orbital plate of the superior maxillary sent a process between the os planum and the lachrymal to articulate with the frontal (Pl. I. fig. 4); when a fronto-maxillary articulation occurs in the inner wall of the orbit, it marks a reversion to the pithecoid arrangement, and is a sign of degradation of the human cranium; for in the Gorilla and other species of *Troglodytes* the os planum is triangular, and the frontal and superior maxilla articulate with each other between it and the lachrymal on the inner wall of the orbit. In two, faint indications of a maxillo-premaxillary suture were seen on the hard palate. The malar was not in any specimen divided either wholly or partially by a suture, and did not therefore conform to a character which Rolleston thought to be not unfrequent in Bush crania. One skull had a long right paramastoid which possessed a broad smooth articular surface at its lower free end for the transverse process of the atlas.

The lower jaw was present in six crania. In all the chin was feeble and with but a slight forward projection; the coronoid process was short, the sigmoid notch shallow, and the incisors almost vertical. The antero-posterior diameter of the ascending ramus, on a line with the alveolar border, was, as a rule, from 30 to 31 mm. In four adults the angle was everted at the insertion of the masseterics, very markedly so in two specimens, and there was only a slight hollowing on the inner surface of the ramus. In all the gonio-symphysial and intergonial diameters were either equal or almost equal.

In the six adult crania the mean cephalic index was 75·9, and the range of variation from the minimum 75 to the maximum 76·5 was only 1·5; the skulls were therefore mesaticephalic. The mean vertical index was 71, and the range from 69 to 73 was 4. The mean height was therefore distinctly below the mean breadth, and in no specimen did the height equal the greatest breadth; the skulls were tapeinocephalic. The mean gnathic index was 96·7, and the range from the minimum 92·6 to the maximum 102 was

9·4; the average was orthognathic, only one adult being mesognathic. The mean facial index was 65, and the range from 62 to 69 was 7. The mean nasal index was 54·85, and the range from 48 to 62·5 was 14·5; the mean was platyrhine, but the individual crania ranged from the lowest term of the mesorhine to the platyrhine. The mean orbital

TABLE I.—BUSH RACE, SOUTH AFRICA.[1]

	Collection,	Uitenhag.	Chal. A.	Chal. B.	E.U.A.M.	Umzimkulu. E.U.A.M.	Drift. E.U.A.M.	Drift. E.U.A.M.
	Age,	Aged.	Ad.	Ad.	Ad.	Ad.	Aged.	8 or 9
	Sex,	F.	M.	M.	M.	M.*	M.	F.?
	Cubic capacity,	1092	1135	1365	1420	1240	1435	...
	Glabello-occipital length,	170	177	177	186	182	182	174
	Ophryo-occipital ,,	170	176	175	183	180	182	174
	Basi-bregmatic height,	123	130	129	130	130	126	119
	Vertical Index,	*72*	*73*	*73*	*70*	*71*	*69*	*68*
	Minimum frontal diameter,	95	88	96	96	92	95	...
	Stephanic ,,	107	98	112	116	98	118	100
	Asterionic ,,	107	102	107	116	104	105	106
	Greatest breadth,	130*p*	132*s*	134*s*	141*s*	138*p*	139*p*	134*s*
	Cephalic Index,	*76·5*	*75*	*76*	*76*	*76*	*76*	*77*
	Horizontal circumference,	482	493	498	520	503	523	485
	Frontal longitudinal arc,	120	135	131	125	130	133	121
	Parietal ,, ,,	125	115	105	148	124	132	123
	Occipital ,, ,,	104	118	126	110	112	105	106
	Total ,, ,,	349	368	362	383	366	370	350
	Vertical transverse arc,	272	294	293	300	288	300	286
	Length of foramen magnum,	35	33	39	36	32	36	37
	Basi-nasal length,	90	93	95	98	104	100	88
	Basi-alveolar length,	88	89	88	100	99	...	90
	Gnathic Index,	*97·7*	*96*	*93*	*102*	*95*	...	*102*
	Interzygomatic breadth,	119	118	119	...	125	126	114
	Intermalar ,,	110	108	110	...	116	114	100
	Ophryo-alveolar length,	75	77	82	81	78	...	69
	Naso-alveolar ,,	57	59	64	60	58	...	53
	Facial Index,	*63*	*65*	*69*	...	*62*	...	*60·5*
	Nasal height,	42	43	48	45	48	44	37
	Nasal width,	25	21	23	24	30	22	23
	Nasal Index,	*59·5*	*49*	*48*	*53*	*62·5*	*50*	*62*
	Orbital width,	36	38	37	37	38	36	32
	Orbital height,	30	31	31	28	29	32	30
	Orbital Index,	*83*	*82*	*84*	*76*	*76*	*89*	*94*
	Palato-maxillary length,	...	...	48	58	53	...	48
	Palato-maxillary breadth,	...	58	56	65	68	61	58
	Palato-maxillary Index,	...	...	*117*	*112*	*128*	...	*121*
Lower Jaw.	Symphysial height,	27	31	31	...	28	31	26
	Coronoid ,,	42	58	50	...	54	51	49
	Condyloid ,,	41	49	45	...	47	45	41
	Gonio-symphysial length,	83	86	85	...	89	90	79
	Inter-gonial width,	83	85	89	...	89	89	79
	Breadth of ascending ramus,	35	31	31	...	31	31	30·5

[1] In this and the succeeding tables Chal. signifies the Challenger Collection; E. U. A. M., the Anatomical Museum of the University of Edinburgh. * With pelvis.

index was 81, and the range from 76 to 89 was 13; the orbits were microseme, with the exception of one which was mesoseme. The mean palato-maxillary index was 119, and the range from 112 to 128 was 16; the palato-alveolar region was therefore brachyuranic. The mean cubic capacity of the five adult male crania was 1319 c.c., the maximum 1435, the minimum 1135, the range being 300 cubic centimetres; the internal capacity of the adult female was only 1092 c.c.; in their average capacity the skulls were microcephalic, but three specimens were mesocephalic.

The skulls were therefore in their average proportions mesaticephalic, tapeinocephalic, cryptozygous, orthognathic, platyrhine, mesoseme brachyuranic and microcephalic.

Crania said to belong to the Bush race have been described, and in several instances figured, by Blumenbach,[1] Sandifort,[2] W. C. L. Martin,[3] Owen,[4] Williamson,[5] Van der Hoeven,[6] Vrolik,[7] Barnard Davis,[8] Fritsch,[9] Zuckerkandl,[10] Flower,[11] de Quatrefages with Hamy,[12] and Rolleston.[13] The precise localities in south Africa in which the Bush people lived, to whom the majority of these skulls belonged, have unfortunately not been stated; but the districts from which others, as well as some of those now described by myself, were obtained, are recorded. They have been procured from a wide geographical area, extending from Clanwilliam and Calvinia on the west, to the sources of the Umzimkulu and St. John's rivers on the east, and ranging northwards and eastwards through the Transvaal to the country between the Tati and Ramaquehan rivers in Matabele Land. The last-named locality, in lat. 20° 54′ long. 27° 42′, is the most northerly spot from which Bush skulls have as yet been obtained. These specimens were collected by the late Mr. Frank Oates,[14] and were described by the late Dr. Rolleston. But the range of these people is even greater than is implied in the above statement, as they probably form scattered hordes in the middle of the continent extending northwards to the 19th or 20th degree of latitude, and also reach the west coast in the district

[1] Decas quinta collectionis suæ Craniorum, p. 12, pl. xlv.

[2] Tabulæ Craniorum.

[3] Natural History of Man and Monkeys, p. 298, 1841.

[4] Catalogue of Osteological Series in Museum of Royal College of Surgeons, vol. ii. p. 832, 1853. Anatomy of Vertebrates, vol. ii. p. 564, 1866.

[5] Observations on Human Crania in Army Medical Museum, Chatham, *Dublin Quarterly Journal of Medical Science*, May and August, 1857, and as a separate reprint.

[6] Catalogus Craniorum diversarum gentium, Leyden, p. 58, 1860.

[7] Musée Vrolik, p. 55.

[8] Thesaurus Craniorum, p. 216, 1867.

[9] Die Eingeborenen Süd-Afrika's, p. 410, 1872. Also, Die afrikanischen Buschmänner als Urrasse, in *Zeitschr. für Ethnologie*, Bd. xii. p. 289, 1880.

[10] Reise der Novara, Anthropologischer Theil, pp. 55, 64, 1875.

[11] Catalogue of Osteological Specimens, pt. i., p. 246, 1879.

[12] Crania Ethnica, p. 389, 1882.

[13] Appendix to Matabele Land, by Mr. Frank Oates, p. 273, 1881, and reprinted in Rolleston's collected Scientific Papers and Addresses, edited by Prof. Turner, p. 462, Oxford, 1884.

[14] Matabele Land and the Victoria Falls, p. 231, London, 1881.

of Great Namaqua Land.[1] It is probable that before, and in the early days of, the European colonisation, tribes of Bushmen lived as far south as the Cape itself, so that one may agree with the following statement made by Dr. Fritsch[2] that throughout South Africa, from the Cape up to the Zambesi, and probably still further north, the territory of the Bush people had extended.

The skulls ascribed to the Bush race, including those described in this Report, which have now been examined by craniologists, are at least forty-six in number, and of these about two-thirds are apparently male skulls. A sufficient number has therefore been studied to enable one with some degree of certainty to state the characters of the Bush skull.

From a comparison of the several descriptions it is evident that in these crania the forehead approaches the vertical; the frontal and parietal eminences are as a rule prominent; the skull is flattened on the vertex; the glabella and supraciliary ridges are not strongly marked, although Fritsch regards them as more prominent than in the skull of the Hottentot; the nasal region is flattened, and the nasal bones enter into the profile outline of the face only by their lower ends, so that the Bush profile markedly contrasts with that of such skulls as the Fuegian drawn on Pl. I.; the malar bones project forwards; the nasal spine of the superior maxillæ is feeble; the skull generally is small.

The length and breadth of thirty-six crania have been recorded by Van der Hoeven, Vrolik, Barnard Davis, Fritsch, Zuckerkandl, Flower, de Quatrefages with Hamy, Rolleston, and myself. If we exclude one described by Zuckerkandl (No. 67), the cephalic index of which was 66·6, and another by Barnard Davis with a cephalic index 67 (No. 388, Thesaurus Craniorum), both of which from their extreme narrowness were probably either deformed skulls or not crania of the Bush race, the mean length-breadth index of the remaining thirty-five crania was 75·2, which places the skulls in the mesaticephalic division. Of these specimens twenty-three had a cephalic index of 75 or upwards, and the highest of these, a specimen described by Rolleston, being one of the males collected by Mr. Frank Oates, had an index of 81. The remaining twelve fell below 75, and the lowest of these were specimens described by Fritsch and Vrolik which had the cephalic indices respectively of 69·4 and 69·9.

On comparing my series of crania with the published figures of other specimens, there is obviously a difference in the amount of backward projection in the occipital region. This is especially to be noted in the skull originally described by Blumenbach, a profile view of which has recently been given by MM. de Quatrefages with Hamy (p. 391,

[1] Stieler's Hand-Atlas, Nos. 71, 72, Gotha, 1882.

[2] Die Eingeborenen, &c., p. 386. Fritsch gives the mean height of six Bushmen as 144·4 cm., and of five women as 144·8 cm., so that the women were 0·4 cm. taller than the men. This is similar to the experience of Dr. Louis Vincent who states (*Revue d'Anthropologie*, t. i. p. 453, 1872) that it is seldom that a Bush person exceeds 1·40 m. in height; that the mean height is 1·30 m., and that the women are a little taller than the men.

fig. 347). This skull has a cephalic index of 73·03, and is therefore distinctly dolichocephalic, its more elongated index being apparently due to its occipital projection. Dr. Williamson also, who does not, however, give any measurements, states that the occiput is well rounded and frequently prominent in Bush crania.

The height of thirty-two crania has been given by Barnard Davis, Fritsch, Flower, de Quatrefages with Hamy, Rolleston, and myself, and the mean vertical index of these specimens is 71, which precisely corresponds with the mean of my six adult crania. Seventeen of these crania had a vertical index of either 71 or less, and in one skull described by Prof. Rolleston the index was as low as 65; in another, from Mr. Oates's collection, described by the same anatomist, it reached as high as 78, but this was quite exceptional. The Bush crania, therefore, are decidedly tapeinocephalic. It is obviously a general character of the Bush skull that the vertical diameter is less than the greatest breadth.

In fifteen crania a gnathic index has been calculated by Flower, Rolleston, and myself, from a comparison of the basi-nasal with the basi-alveolar diameters. The mean index in these specimens was 97·9, which places the skulls in the orthognathic series. Several of the specimens were, however, above 98, which is taken as the upper limit of orthognathism, and three reached 102; so that individual skulls have a forward projection of the upper jaw considerably above the average of the race, but in no instance did they attain that degree of prognathism which is characteristic of the negro. The want of projection of the upper jaw in these people is also testified to by Dr. Williamson, who in his excellent description of the Bush crania in the Army Medical Museum states that "the alveolar processes are straight and broad in front, and do not project, but the position of the sockets causes the teeth to stand forwards."

The nasal index has been computed in twenty-one specimens by Flower, de Quatrefages with Hamy, Rolleston, and myself, and the mean index is 58·4, which places these skulls well into the platyrhine series. The mean of this large series of crania is, however, less than that obtained by either Flower, de Quatrefages with Hamy, or Rolleston, in their respective series, owing to the low mesorhine indices (48, 49, 50) in three of the specimens which I have recorded, and yet these mesorhine crania had in other respects well-marked Bush characters. The width of the nasal aperture is also specially referred to by both Williamson and Fritsch as a feature in the Bush skull.

The orbital index has been calculated in the same twenty-one specimens, and the average is 83, which places the skulls in the microseme series. A considerable range, however, prevailed in this index, for in a skull described by Dr. Rolleston it was as high as 100, and in another skull measured by the same anatomist it fell to 73.

The palato-maxillary index has as yet only been recorded in the skulls described in this Report; the mean of the measurements of four crania being 119·5, which places these skulls in the brachyuranic series.

The mean internal capacity of Prof. Flower's specimens was 1252, that of Dr. Rolleston's 1285, of my own 1281. All therefore are microcephalic.

As a result of the examination of the collective measurements of the extensive series of Bush crania which have now been recorded by craniologists, one may state that these skulls are on the average mesaticephalic, tapeinocephalic, orthognathic, platyrhine, microseme and microcephalic. This result corresponds therefore with that at which Flower, Rolleston, and myself had independently arrived from the examination by each of us respectively of the series of crania which had passed through our hands.

Dr. Rolleston has also directed attention to the form of the lower jaw as very characteristic of the Bush cranium. My specimens closely corresponded in the feebleness of the chin, the lowness of the coronoid process, the shallow sigmoid notch, and the everted angle with his description, but the hollowing out below the internal dental foramen to which he also refers was not specially noticeable. Further, I may point out another character which obviously deserves consideration, viz., the almost equality in length between the diameter from the angle of the jaw to the chin, and that between the opposite angles of the same bone. In each skull the basi-nasal and the basi-alveolar diameters exceeded the gonio-symphysial length, and similarly the intergonial diameter was always below the minimum frontal diameter in the same cranium.

Dr. Fritsch also lays considerable stress upon the breadth of the face, on that of the skull in the spheno-frontal region, and indeed on the breadth of the transverse measurements generally, in the Bush crania. In my description (p. 11) I have pointed out how the transverse diameter in the parietal region greatly dominated over the interzygomatic, so that the skulls were cryptozygous.

FUEGIAN AND PATAGONIAN.

Plates I., VI. Tables II., XVIII., XIX.

The crania marked Fuegian consisted of four adult specimens, only one of which possessed a lower jaw. This specimen was soldered up in a zinc case marked "Head of a Fuegian," but all the flesh had been removed and the brain was putrid; it is the skull D in the following description. One skull was marked Patagonian. All these crania were obtained at Puntas Arenas, in Magellan's Strait, and were presented as undoubted Fuegian skulls to Sir Wyville Thomson by Don Diego Dublé Almeida, the Governor of the Chilian colony. Two of the Fuegian crania were somewhat injured, but the other two and the skull marked Patagonian were in good condition.

FUEGIAN.—The Fuegian skulls are distinguished in the following description by the letters A to D inclusive. A and D were males, C was a female. B was more difficult to determine, but probably a female.

Norma verticalis.—These crania had no marked antero-posterior elongation. The line of the sagittal suture was elevated into only a slight ridge, except in A, in which, however, the region of the anterior fontanelle was flattened. Between the sagittal suture and the parietal eminences and temporal ridge the vault was somewhat flattened, and sloped downwards and outwards, so as to give what Prof. Cleland names an "ill-filled" character to this region of the skull. The eminences themselves were distinct, though not particularly prominent, and below them each skull bulged out slightly, so that the greatest breadth was in the squamous region. A and B were distinctly phænozygous, D slightly so, C not at all. In three of these skulls the asterionic diameter was slightly more than the stephanic in the same specimen. In the fourth the stephanic was 7 mm. more than the asterionic diameter.

Norma lateralis.—The skulls rested in front on the crowns of the upper molars, and behind on the cerebellar region of the occiput. In A and D the glabella and supraciliary ridges were distinct, but in B and C comparatively feeble. The profile outline formed a continuous curve from the glabella to about the obelion, but from that region the skull sloped downwards and backwards to the occipital point, and was somewhat flattened. In B this slope was more nearly vertical, but in none of the crania was there evidence of artificial parieto-occipital flattening. The occipital squama projected behind the protuberance, but in A a well-marked mesial depression existed between the protuberance and the superior angle. The frontal longitudinal arc in one case exceeded the parietal, the parietal and frontal arcs in one skull each exceeded the occipital, but in the others the occipital arc was the longest. The basi-nasal diameter in each specimen was longer than the basi-alveolar.

The nasal bones were elongated, and ranged from 26 to 31 mm.; their width varied from 11 to 15 mm. They projected downwards and forwards, and the bridge of the nose was prominent and concavo-convex from root to tip, and formed a marked feature in the facial aspect of these crania. The nasal spine of the superior maxillæ was strong in both A and D. The junction of the side walls with the floor of the anterior nares was not much rounded. In three of the crania there was a marked depression of the frontal bone, immediately above the external orbital process, which gave prominence to that part of the orbital border. This depression extended upwards and backwards in front of the temporal ridge, and, owing to the feebly developed frontal eminences, contributed to impart a slope to the forehead from the external orbital process and temporal ridge upwards and inwards towards the mesial line of the frontal. The temporal ridge in two of the crania was strong and in all divided into an upper and a lower part.

In each skull the interzygomatic diameter was much greater than either the stephanic or asterionic, and in every skull but C the intermalar diameter also exceeded the stephanic and asterionic. In two cases the interzygomatic diameter was slightly more than the greatest breadth in the parieto-squamous region, and in the other two it was decidedly

less. The inter-orbital width was either 21 or 22 mm. In D, the only one which had a lower jaw, the length of the face from the ophryon to the chin was 140 mm., and from the fronto-nasal suture to the chin 118 mm.

The teeth in all were fully erupted, though many of the sockets were empty. In A and B the crowns were much worn and flattened, but there was no decay.

The cranial sutures, except in C, were simple in their denticulations. In A and B they

TABLE II.—FUEGIAN AND PATAGONIAN.

		Fuegian. Chal.				Patagonian.
		A.	D.	B.	C.	Chal.
	Collection,	Ad.	Ad.	Ad.	Ad.	Ad.
	Age,	M.	M.	F?	F.	M.
	Sex,	1390	1362	1190	1392	1290
	Cubic capacity,	182	186	175	182	182
	Glabello-occipital length,	179	183	175	182	181
	Ophryo-occipital „	137	138	133	132	141
	Basi-bregmatic height,	*75*	*74*	*76*	*72·5*	*77*
	Vertical Index,	102	95	97	96	99
	Minimum frontal diameter,	112	108	108	114	112
	Stephanic „	113	114	110	107	110
	Asterionic „	141*s*	136*s*	137*s*	142*s*	141*s*
	Greatest breadth,	*77·5*	*73*	*78*	*78*	*77·5*
	Cephalic Index,	520	520	493	515	521
	Horizontal circumference,	122	125	110	130	124
	Frontal longitudinal arc,	123	115	119	...	110
	Parietal „ „	120	133	122	...	140
	Occipital „ „	365	373	351	372	374
	Total „ „	322	300	282	308	297
	Vertical transverse arc,	38	36	32	35	35
	Length of foramen magnum,	106	106	102	100	101
	Basi-nasal length,	104	102	97	...	101
	Basi-alveolar length,	*98*	*96*	*95*	...	*100*
	Gnathic Index,	143	130	139	130	144
	Interzygomatic breadth,	127	117	123	112	125
	Intermalar „	90	100	93	...	101
	Ophryo-alveolar length,	66	70	70	...	75
	Naso-alveolar „	*63*	*77*	*67*	...	*70*
	Facial Index,	52	54	51	...	53
	Nasal height,	22	22	25	21	26
	Nasal width,	*42*	*41*	*49*	...	*49*
	Nasal Index,	39	39	38	38	39
	Orbital width,	34	36	36	37	38
	Orbital height,	*87*	*92*	*95*	*97*	*97*
	Orbital Index,	58	54	54	...	55
	Palato-maxillary length,	63	60	62	62	66
	Palato-maxillary breadth,	*109*	*111*	*115*	...	*120*
	Palato-maxillary Index,	...	31	...	...	...
Lower Jaw.	Symphysial height,	...	73	...	...	...
	Coronoid „	...	68	...	...	...
	Condyloid „	...	99	...	...	...
	Gonio-symphysial length,	...	94	...	...	...
	Inter-gonial width,	...	41	...	...	...
	Breadth of ascending ramus,					

were in course of being ossified, and these skulls were of more advanced age. In C a well-marked triquetral bone formed the superior angle of the occipital squama, and a large Wormian bone was in the right pterion. In none did the temporal squama articulate with the frontal, or was the frontal suture persistent. In all the os planum of the ethmoid had a quadrilateral form. In none was the maxillo-premaxillary suture visible on the palatal surface. In all the hard palate was hollowed into a deep fossa where the posterior palatine foramen opened, and in three of the crania this fossa had a depth of 15 mm. opposite the second molar. The exoccipitals were tumid on the inferior surface, and in B slightly, but in D more definitely, projected downwards, so as to form a short paramastoid process.

The lower jaw of D was a well-developed bone, with a good chin. The angle was almost rectangular but not everted, and the teeth were all present. The gonio-symphysial length was somewhat greater than the intergonial width.

The mean cephalic index of the four crania was 76·6: the maximum (female) was 78, the minimum (male) 73. The crania were therefore mesaticephalic, three being above its lowest term, but D was dolichocephalic. When D was omitted the mean cephalic index of the rest was 77·8. The mean vertical index was 74·4: the maximum 76, the minimum 72·5, both females. The height was somewhat below the mean breadth; only in D, a male, did the height exceed the breadth, and in the undoubted female skull the smaller relative height was well marked. In three cases the vertical index was less than the cephalic. The skulls were metriocephalic. The mean gnathic index was 96: the maximum (male) 98, the minimum (female) 95. The face was therefore orthognathic. The mean facial index was 69: the maximum (male) 77, the minimum (female) 63. The mean nasal index was 44: the maximum (female) 49, the minimum (male) 41. The nose was therefore leptorhine, only one specimen slightly exceeding its highest term. The mean orbital index was 93: the maximum (female) 97, the minimum (male) 87. All the skulls were megaseme, except one male, which was mesoseme. The mean palato-maxillary index was 111·5: the maximum (female) 115, the minimum (male) 109; there was no great disproportion between the length and breadth of the palato-alveolar region; the index of which was mesuranic. The mean capacity of the four crania was 1333·5 cubic centimètres; that of the two presumable males was 1376; that of the two presumable females 1291 c.c. The two males were mesocephalic, whilst the average of the females, as well as that of the series of four skulls, was microcephalic.

These Fuegian crania were therefore on the average mesaticephalic, metriocephalic, tending to phænozygous, orthognathic, leptorhine, megaseme, mesuranic and microcephalic.

PATAGONIAN.—The single skull marked Patagonian was an adult male. It corresponded in general form with the Fuegian A. It had the same cephalic index 77·5, and was therefore mesaticephalic. Its vertical index, greater than in A, and almost as high as its

cephalic index, was just akrocephalic. The stephanic diameter slightly exceeded the asterionic, but both were below either the interzygomatic or intermalar. The interzygomatic was slightly more than the greatest transverse diameter in the parieto-squamous region. The interorbital width was 24 mm. The frontal longitudinal arc was greater than the parietal, and both were considerably below the occipital. The basi-nasal and basi-alveolar length were equal, and the index was mesognathic. The skull was phænozygous. It was depressed in the frontal region above the external orbital process. The palatal fossa was 17 mm. deep opposite the second molar. The nasals were 30 mm. long, and the bridge of the nose was prominent and concavo-convex. The pterion was normal, and there were no Wormian bones. The skull rested behind on the cerebellar region of the occiput. In its capacity of 1290 c.c. it was microcephalic. In its facial characters and proportions it differed from A in the following:—the gnathic, facial, nasal, orbital, and palato-maxillary indices were all greater, but the facial, nasal, and orbital indices did not exceed the corresponding indices of others of the skulls marked Fuegian. It showed no sign of artificial deformity.

Very few Fuegian skulls have been examined by craniologists. The specimens contained in museums, and up to this time recorded, do not apparently exceed nine in number, and of these six are apparently males and three females. The authorities who have written on these crania are Professors Owen,[1] Huxley,[2] Flower,[3] and de Quatrefages with Hamy.[4] To this list are now to be added the four skulls described in this Report.

Prof. Owen's description is limited to a single male skull, which, together with a considerable part of the skeleton, is in the Museum of the Royal College of Surgeons of England (No. 5428, Old Cat.). The same skull is figured by Prof. Huxley, and a brief reference is also made by him to another cranium, probably that of a young woman, collected by Dr. R. O. Cunningham at Philip Bay. Prof. Flower gives the principal measurements (No. 1025, New Cat.) of the skull already described by Owen and figured by Huxley, as well as of two other crania from Fuegia (Nos. 1026, 1027), and since the catalogue was published two additional specimens have been presented to the College of Surgeons, the one, a male, found in a shell heap near Ooshooia, the measurements of which are recorded in manuscript in the museum copy of the catalogue (No. 1025, *a*),[5] the other of a young girl about 15 (No. 1027, *a*). MM. de Quatrefages and Hamy have recorded the measurements of two crania, one of which, from Desolation Land, they have figured in pl. lxxv. figs. 3 and 4.

The measurements and figures of such of the skulls as have been published show that

[1] Catalogue of Ost. Series in Mus. Roy. Col. Surgeons, vol. ii. p. 846, 1853.

[2] *Journal of Anatomy and Physiology*, vol. ii. p. 253, 1868.

[3] Cat. of Ost. Specimens, pt. 1, p. 179, 1879.

[4] Crania Ethnica, p. 478.

[5] Prof. Flower gives the cephalic index as 73·4, the vertical index as 71·9, the gnathic as 100·9, nasal 49·1, and orbital index 95·1. The skeleton was said to be that of a remarkably tall man.

they varied considerably in the relation of the length and breadth of the cranium. The two measured by MM. de Quatrefages and Hamy had a mean cephalic index 74·8, whilst those measured by Prof. Flower ranged from 73·4 to 81·8. Similarly the four skulls described by me in this Report varied considerably, the lowest D being 73, whilst the others were either 77·5 or 78. The skull which Prof. Huxley figured had a cephalic index 74, so that he draws the conclusion that the Fuegian skull is dolichocephalic, and with this conclusion MM. de Quatrefages and Hamy concur. But if we take the whole series of eleven skulls, including those published in this Report, the cephalic indices of which have been recorded, we shall find that only six were below 75 (the lowest being 73), whilst the mean of the series was 76·5. Hence, if 75 be regarded as marking the highest term of dolichocephalism, the average index places them in the mesaticephalic group, though somewhat more than one-half were dolichocephalic. Notwithstanding the high mesaticephalic index of three of the skulls which I have described, the parieto-occipital region in them had much more the shape to be seen in skulls of dolichocephalic than of brachycephalic proportions, and the parietal eminences were not set so far back on the side of the cranium as one sees in brachycephalic skulls. The specimen D which I have figured (Pl. I. figs. 5, 6) closely corresponded in its contour with the skull figured by Prof. Huxley and with that delineated by MM. de Quatrefages and Hamy.

To afford a convenient opportunity of making a comparison, I reproduce, from the Journal of Anatomy and Physiology, the four views of the Fuegian skull figured by Prof. Huxley.[1]

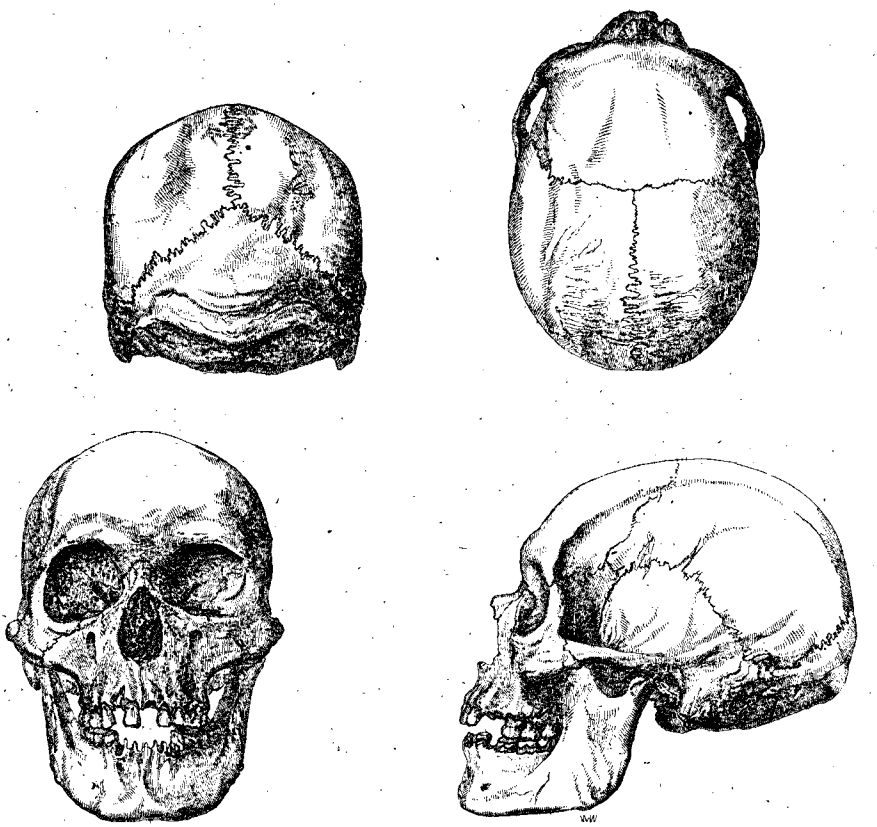
There can, I think, be no question that D is an authentic specimen of a Fuegian skull, not only from its resemblance to those above referred to, but because, from the attempt, unfortunately unsuccessful, to preserve the brain, the man must have died at Sandy Point, and was doubtless known to have been a Fuegian. My other specimens, although differing in their cephalic indices so much from the skull D, yet agree with it in many other of its characters, and are probably also the skulls of Fuegians who had died at Sandy Point, to which settlement some of the tribes of Tierra del Fuego are accustomed to resort for the purposes of barter.

The two skulls, said to be males, measured by MM. de Quatrefages and Hamy, had a mean vertical index of 76·4, *i.e.*, 1·6 higher than their mean cephalic index; hence these authorities state that the Fuegian skull is hypsistenocephalic. In one of the eight skulls, the heights of which have been given by Prof. Flower and myself, the vertical index was greater than the cephalic (D. in my Table II.), and in the male skull figured by Mr. Huxley the vertical and cephalic indices were equal (73·9), but in the remaining six, three of which are presumably males, the vertical index was decidedly less than the cephalic; the mean of the series of ten crania was 73·87; hence they are metriocephalic.

[1] I may state that these views of the Fuegian skull have also been reproduced by MM. de Quatrefages and Hamy in the Crania Ethnica, p. 477, figs. 434–437.

The mean of the seven males was 73·4; of the three females 74·8, so that their vertical index was higher than the males, which is exceptional to the general rule in the two sexes.

The nasal and orbital indices have been determined in the skulls examined by MM. de



FIGS. 1, 2, 3, 4. Occipital, vertical, facial, and lateral, aspects of Fuegian skull in Mus. Roy. Col. Surgeons, London, No. 1025.

Quatrefages and Hamy, Prof. Flower, and myself. The mean nasal index in eight crania was 44·68, the minimum 41, the maximum 49·1, so that the average of this larger number was almost the same as in my smaller series, and confirms the leptorhine character of the nose of these people. The mean orbital index in nine crania was 91·1, the

minimum 84·2, the maximum 97; so that the megaseme character of the orbit is obviously the rule, although three specimens had mesoseme proportions.

The gnathic index has been determined in six specimens by Prof. Flower and myself. Owing to the higher index in the College of Surgeons specimens (ranging from 100·9 to 105·9) than in those collected by the Challenger, the mean of the entire series was 99·76, which places them in the mesognathic division, though, as the range was from 95 in a female skull to 105·9 in a male, individual skulls were either orthognathic, mesognathic, or prognathic.

The internal capacity has been taken in seven specimens by Prof. Flower and myself. The mean contents of the brain case were 1309 cubic centimètres, which places them in the microcephalic series, and the range was from 1190 in the skull B, which I have regarded as probably a female, to the male skull figured by Prof. Huxley, the capacity of which was 1420 c.c.

From the above analysis one may summarise the general characters of the Fuegian skulls as follows:—mesaticephalic, metriocephalic, mesognathic, leptorhine, megaseme, and microcephalic. This analysis of the whole series of skulls to the records of which I have had access agrees, except in the degree of projection of the upper jaw, with the results I had arrived at from the examination of the four specimens described in this Report.

During the years 1881 and 1882, a party of Fuegians, consisting of four men, four women, and three young children visited Europe, and were examined by numerous anthropologists in Paris, Germany and Switzerland.[1] They appear to have belonged to the Alaculoof tribe, and according to the Rev. Thos. Bridges[2] were not from Hermite Island, in immediate proximity to Cape Horn, as is stated by M. Topinard and by Prof. Virchow, but from Dawson Island to the north-west of Admiralty Sound. Measurements of the body, of the head and face are given independently by M. Manouvrier and by Prof. Virchow. The mean length of the head in the four men is stated by M. Manouvrier to be 196·7; that of the four women 193·2; the mean breadth is given as 157·2 in the men and 155 in the women; the cephalic index of the males is 79·9,

[1] A most interesting account of these people, as observed during September 1881, was given by M. L. Manouvrier, M. Topinard, and other French anthropologists, to the Société d'Anthropologie de Paris (*Bulletins*, Nov. 17, and Dec. 15, 1881, ser. 3, vol. iv. pp. 760, 841); also by Prof. Virchow to the Berliner Gesellschaft für Anthropologie, Nov. 14, 1881 (*Zeitschrift für Ethnologie*, Bd. xiii. 1881, p. 375). Prof. Bischoff has also written a short brochure on their physical and psychical characters, entitled "Die Feurländer in Europa," Bonn, 1882, and he has also communicated to *Sitzungsb. d. K. B. Akad. der Wiss.*, Feb. 4, May 6, 1882, two papers on the female genital organs and functions. In *Virchow's Archiv*, Bd. xci. p. 154 and p. 446, 1883, Dr. J. Seitz of Zurich describes the illness and death of five members of the troop, and gives an account of the *post mortem* appearances; he also contributes some observations on their habits and character. The Rev. Thos. Bridges states that only four returned to Fuegia, a youth, a middle-aged woman, and two children (see reference in next footnote). Dr. Seggel gave an account to the Anthropologische Gesellschaft of Munich of the eyes of the Fuegians (*Archiv für Anthropologie*, Bd. xiv. 349, 1883). In February 1884 Dr. Hyades, a member of the French Scientific Mission to Cape Horn, contributed to the *Bull. de la Société d'Anthropologie*, some observations on the Tekeenika tribe, more especially on their language, and as a supplement to his paper he translates one on their manners and customs by the Rev. T. Bridges.

[2] *South American Missionary Magazine*, Nov. 1, p. 254, 1882.

that of the females 80·2. Virchow from his measurements places the cephalic index in the men at 79, whilst that of the two women whom he examined is in the one case 79·6, in the other 80·6, with a mean of 80·1; the mean of the series of six heads was 79·4. Both these observers therefore agree in placing the mean cephalic index of these Fuegian heads in the highest term of mesaticephalism, or the lowest of brachycephalism, which is somewhat higher than the mean of 76·5 deduced from the eleven crania which have up to this time been examined. One can no longer therefore say that the Fuegians are as a whole a dolichocephalic race. The mean stature of the four men is stated by M. Manouvrier to be 1^{m}·612, *i.e.*, 5 feet 3½ inches, whilst Virchow gives 1645 mm., *i.e.*, 5 feet 4¾ inches as the height of Hendrich the tallest of the men.

The question however arises, may there not be more than one race of people dwelling in the islands of the Fuegian archipelago? Herr von Böhr, who sailed in Magellans Strait in 1879,[1] examined the heads of some men who visited his ship in their canoe about 20 nautical miles west of Cape Froward. He states that the skull was elongated, conspicuously high, and tapering off from the sides towards the vertex in a ridge. He took the greatest breadth and length, "mit einem etwas groben Tasterzirkel," and gives the cephalic index of three men as respectively 70, 73, and 77, or a mean of 73·3. Although he admits that his callipers were somewhat coarse, yet his eye had recognised the longish or oblong form of the head in these persons, so that although his measurements may not have been absolutely correct, yet they are probably approximately so. These observations, together with the measurements of certain of the skulls referred to on p. 22, point to the presence of people with dolichocephalic heads amongst the Fuegians. The tallest of the men was 5 ft. 1 in., the shortest 4 ft. 10 in. The proximity of the archipelago to the part of the continent occupied by the brachycephalic Patagonians may perhaps have led to an intermixture of races, so that if, as is not impossible, the original stock of these islands was dolichocephalic, a measure of fusion of the two races may have led to the origin of a people whose heads have mesaticephalic proportions, more or less strongly pronounced according to the proportion in which one or other of the two original races preponderated.

That the inhabitants of Tierra del Fuego are not a homogeneous people has indeed been recognised by more than one traveller. Captain Fitzroy states[2] that the Yacanakunny in the north-east of the large island resemble the Patagonians in colour, stature, and clothing, whilst the Tekeenica, who live in the south-east, are low in stature, ill-looking, and badly proportioned. The Alikhoolip tribe are not unlike, though superior to, the Tekeenica, whilst the Yacanas partake of the peculiarities of both the Patagonians and Fuegians. Captain King also describes the wife of a Fuegian as from her size not

[1] Communication made to the Berliner Gesellschaft für Anthropologie, Jan. 15, 1881 (*Zeitschrift für Ethnologie*, Bd. xiii. p. 30, 1881). Dr. Essendorfer had also, on 30th March 1880, given (*Zeitschrift*, Bd. xii. p. 57) some information about the aspect of the Fuegians, but without any measurements.

[2] Voyage of the Adventure and Beagle, vol. ii. p. 137, 1839. Captain King's description is in vol. i. p. 55.

unlike a Patagonian. Mr. Darwin says[1] that the people of the Bay of Good Success "are a very different race from the stunted miserable wretches farther westward, and they seem closely allied to the famous Patagonians of the Straits of Magellan" (p. 205). And conversely amongst the Patagonians at Cape Gregory, he observed a man with his face painted in white rings and dots like a Fuegian (p. 232). Dr. R. O. Cunningham also observed[2] that the people of the northern part of the large eastern island, the Yacana-kunny, differed strikingly from the western tribes in their much larger stature and in their manner of life, which approached in some particulars to that of the Patagonians. He further expressed the opinion that the southern Fuegian tribes had at a distant period migrated southwards "in consequence of having been evicted from their original territory by more powerful aboriginal nations." The Rev. Thos. Bridges, so well known for his philanthropic and missionary labours amongst the Fuegians, states that the Yahgan people at Ooshooia, where the mission station is, are short of stature, and with short and small arms and legs, the average height of the men being 5 ft. 3½ in., and the women 2½ in. shorter. On the other hand, the Ona tribe at Sloggett Bay are very muscular and well grown people, and of the same stock as the southern Patagonians.[3] The language spoken by each of the tribes of the Yahgans, Onas, and Alaculoofs is also quite distinct, so that one tribe cannot understand another.

I should also state that a collection of Patagonian crania, obtained by M. F. P. Moreno[4] along with numerous flint and other stone implements from ancient cemeteries of the Téhuelches in the valley of the Rio Negro—cemeteries, the exact age of which could not be ascertained, but which from the absence of the bones of the horse in them were probably formed before the introduction of that animal into Patagonia—displayed variations in the relations of length and breadth, though the majority were distinctly dolichocephalic. M. Moreno gives the measurements of forty-five crania, eighteen of which were artificially deformed and twenty-seven without deformity. Of the normal crania eleven were males and sixteen females. The mean cephalic index of the males he places at 75·0; that of the females at 74·15, whilst the mean of the entire series is 74·44. From the table of extreme lengths and breadths I have calculated the cephalic indices in the twenty-seven normal crania, and find that no fewer than sixteen have a cephalic index below 75, and of these four are below 70, the lowest being 67;[5] seven range from 75 to 78·6, and four only are distinctly brachy-

[1] Naturalist's Voyage, ed. 1870.

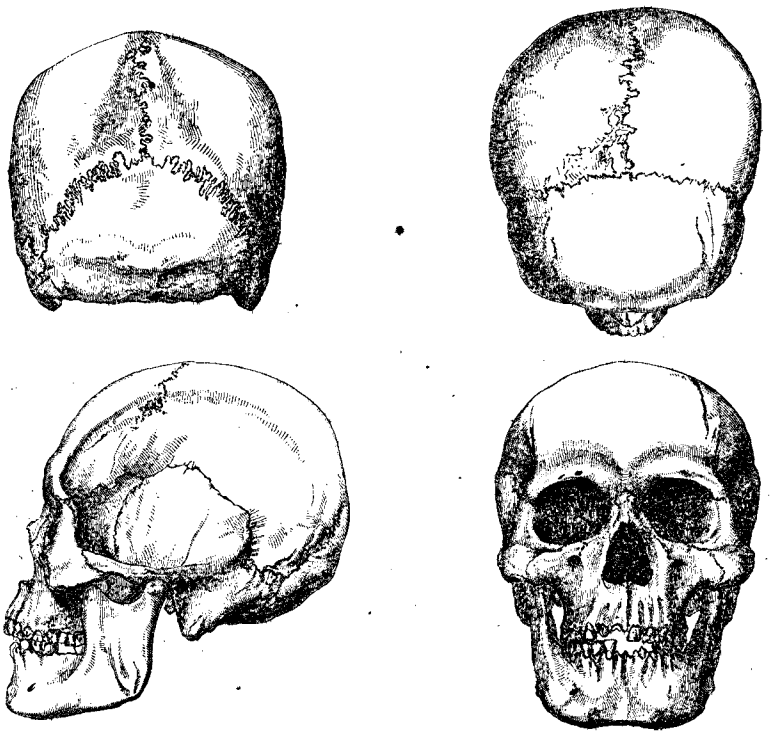
[2] Natural History of Straits of Magellan, 1871.

[3] *South American Missionary Magazine*, Jan. 2 and Oct. 2, 1882.

[4] Description des Cimetières et Paraderos préhistoriques de Patagonie, *Revue d'Anthropologie*, t. iii. p. 72, 1874. Lieutenant Masters has given an interesting account of the customs and physical appearance of the Races of Patagonia, especially of the Téhuelches, in the *Journ. of the Anth. Inst.* vol. i. p. 193, 1872.

[5] One of these skulls has its norma verticalis figured by MM. de Quatrefages and Hamy in the Crania Ethnica, p. 475, fig. 432—the norma facialis and norma lateralis in pl. lxxv, figs. 1 and 2.

cephalic, from 81·1 to 87·9. Prof. Virchow has also described[1] four skulls sent by Dr. Burmeister from the north side of the Rio Negro, two of which were deformed and two normal. Of the latter, one had a cephalic index of 77·4, the other of 70·3; the mean of the two being 73·85, which is almost the same as the much larger series collected by M. Moreno. Hence, it is clear that before the European colonisation of



FIGS. 5, 6, 7, 8.—Occipital, vertical, lateral, and facial aspects of Patagonian Skull from near the river Chupa.

South America a people with dolichocephalic heads inhabited that part of the continent which we now call Patagonia.

The single skull marked Patagonian brought home by the Challenger does not afford me sufficient material upon which to base any conclusion as to the cranial characters of the modern Patagonians. It is indeed open to some doubt if this be a genuine Patagonian, as in its general form and in some of its measurements it so closely resembled the Fuegian

[1] Communication made to Berliner Gesellschaft für Anthropologie (*Zeitschrift für Ethnologie*, Bd. vi. p. 51, 1874).

skull A. Its cephalic index is only 77·5, which is considerably below the mean of 85·3 of the seven Patagonian skulls (three females, four males) measured by Prof. Flower, in the Museum of the Royal College of Surgeons, two of which, however, are artificially deformed. It is also much below the skull of a Patagonian found in a tumulus near the river Chupa, cephalic index 89, figured by Prof. Huxley, whose figures for convenience of reference I have reproduced on p. 27,[1] and to the skull from Carmen, at the mouth of the Rio Negro, recently described by Mr. G. W. Bloxam,[2] the cephalic index of which was 92·6, in which, however, the index is without doubt increased by modification in the shape from occipital pressure. MM. de Quatrefages and Hamy also point out that the Puelches, the people who now occupy the valley of the Rio Negro, where the dolichocephalic race of the Téhuelches once resided, are remarkable for their brachycephalism. It may therefore be a fair subject for enquiry whether a dolichocephalic race did not precede in South America its present brachycephalic inhabitants, which race has been gradually displaced, though its descendants may yet be found in the Guaranis of Bahia[3] and in the Botocudos of Brazil, or pushed far to the southward in the dolichocephalic or, perhaps with some intermixture, also in the mesaticephalic people of the Fuegian archipelago. The difference between the modern Patagonian and the Fuegian is not one of head-form only. They differ also strikingly in their stature and mode of life, and the former in physical characteristics certainly, and probably also in intellectual, is obviously a much superior race to the latter.

AUSTRALIAN.

Plates II., VII. Tables III., IV., V., VI., XVIII., XIX.

Only three aboriginal Australian skulls were collected by the Challenger. One a male, probably from Queensland. A second, a male from Queensland, was obtained along with other bones of the skeleton from a collector. The third, a female from West Victoria, in the Camperdown district, inland from Port Fairy, was presented along with other bones of the skeleton by James Dawson, Esq.[4] In addition I have examined two skulls long in the Anatomical Museum of the University, and a considerable number of crania which I have been engaged for some years in collecting, and for which I am indebted partly to the kindness of W. G. Howitt, Esq. of Melbourne, and partly to that of several of my

[1] *Journal of Anatomy and Physiology*, vol. ii. p. 253. These figures have also been reproduced by Dr. Barnard Davis in his Supplement to the Thesaurus Craniorum, pp. 58, 59, 1875; and by MM. de Quatrefages and Hamy in Crania Ethnica, p. 468.

[2] *Journ. Anthrop. Inst.*, p. 28, Aug. 1882. Length 163 mm., Breadth 151 mm., Height 148 mm.

[3] Retzius in *Müller's Archiv*, 1849, and Ethnologische Schriften, p. 112, shows that the Guarani Indians are dolichocephalic. In the same *Archiv*, 1855, and in Ethnologische Schriften, p. 134, he gives the length and breadth measurements of the skull of a Pampas Indian, with a cephalic index of 88·4.

[4] A most interesting account of the customs, language, &c. of the natives of this part of Victoria has been given by Mr. Dawson in a quarto volume, Australian Aborigines, Melbourne, 1881.

pupils, of whom, from the number of specimens given to me, I may especially name Dr. Frederick Page, and Dr. G. More Reid.

The entire series consisted therefore of thirty-five crania, almost all of which were entire, and a large number possessed the lower jaw. They were from Queensland, New South Wales, Gipps Land, Victoria, South Australia, Lake Alexandrina, Alexandra Land, West Australia, North-West Australia, as far as the de Grey River, and Roebuck Bay.[1] They embrace specimens both of the coast tribes and of tribes much more inland.

With four exceptions they had all reached adult life, whilst some were more advanced in years; the four younger skulls ranged apparently from 16 to 18 years. Of the thirty-one adults twenty were apparently males and eleven females, whilst two of the four youths were males, the others probably females. In the male youths the basi-cranial synchondrosis was unossified. The 1st and 2nd permanent molars were erupted, but the wisdom teeth were still enclosed in their bony alveoli. It is remarkable that in one skull the upper lateral incisors were absent, apparently indeed never developed, and the canine sockets were in close proximity to the sockets for the central incisors. In the young

[1] The skull from Perth, West Australia, was dug up by John Thomson, Esq., Surgeon, along with the bones of the skeleton. The body was buried in the sitting posture, and the knees were the parts first exposed. The skull from the Macquarrie River district was found by Mr. D. Houison, 6 feet below the surface of a large mound of earth. The body, probably that of a chief, had been encased in Eucalyptus leaves 3 or 4 inches thick, and a layer of timber and bark was above the leaves. The trees facing the mound were marked and carved. The skull from Lake Alexandrina was got by Mr. Walter Dickson at the foot of a shea-oak tree, about 80 miles south of Adelaide and about 20 miles from the sea coast. In this district the natives smoke the bodies of their dead; they then swathe them in mats, bending the legs under the body, after which they place them in the forks of the shea-oak trees; as decomposition advances the bones fall to the ground. The Roebuck Bay skull, lat. 18°, was presented to me by Dr. F. Page, who states that the dead are left uncared for on the ground, but that the natives are more intelligent than those of the south-west coast; they make fishing lines and baskets, have heavy clubs and spears, which they do not throw, and have canoes in common use. They wear no clothing, are decidedly black, and are fine well-nourished men averaging 6 feet in height. Fish is their chief food. The Malays occasionally visit them. The Riverina skull, presented along with the skeleton by Dr. G. More Reid, was that of the chief of his tribe: he was said to be about 5 feet 10 inches high. The Coorong skull was obtained by Mr. Clement L. Wragge from a platform or funeral pile in thick tea-tree scrub adjoining the Coorong and mouth of the Murray; the body was rolled in coarse sacks. The Mudgee skull was dug up by Mr. R. Vandeleur Kelly near the banks of the Cudgegong River, New South Wales. The Mudgee tribe bury their dead in a large grave 3 or 4 feet deep, and make a circular mound over the grave, sometimes 10 feet in diameter; the corpse is placed in a sitting posture, with spears, boomerangs, &c., beside it. It is a custom of this tribe to knock out a front tooth, when a boy arrives at puberty. The skull from Eucla was that of a man said to be from 55 to 60, presented by Wm. Williams, Esq. (who also gave the male skull from Fowler's Bay, said to be a man of 40). The skull from the Wannon River was obtained by Mr. Pillean about 10 miles from Portland Bay and about 200 miles west of Melbourne. The Portland Bay skulls were dug up at the Hummocks, near Belfast and Warnamboot. The skull from the Margaret River, near Cape Leeuwin, says Dr. F. Page, was that of a man who had been a herdsman, and who stood 6 feet high, considerably above the average height of the men of his tribe, who are small, badly fed savages, dressed in skins and leading nomadic lives. Food is scarce with them. They live upon roots, with an occasional gorge of Kangaroo. Although close to the sea they do not fish with a net or line, nor do they make or use canoes. The natives of this district are of a mahogany colour, with long black hair and dark brown eyes. They bury the dead in the sitting posture and raise a tumulus over the grave. The Benalla skulls are from a place between the Goulburn and Murray Rivers, about 150 miles north of Melbourne; the male is said by Mr. James Grice, who dug them up, to be about 60, the female about 24. The specimen from the de Grey River was in the collection of the late Dr. Handyside, but has now been acquired for the Anatomical Museum of the University of Edinburgh.

females the basi-cranial synchondrosis was also unossified, the 1st and 2nd permanent molars were erupted, but the wisdom teeth had not come to the surface. In one of these a unicuspidate tooth occupied a cavity in the palatal plate of the left superior maxilla, behind the incisive canal and parallel and close to the intermaxillary suture. It lay horizontally, parallel to that suture, and with what seemed to be its crown directed backwards. The incisors, canines, bicuspids, and 1st and 2nd molars had all erupted in their proper order, so that this palatal tooth was a supernumerary *dens*.

It might seem scarcely necessary that I should enter into a minute description of the characters of the crania of the aboriginal Australians, as so much has been written on that subject by preceding craniologists; but as these skulls have been collected from so wide an area, and as the precise locality of collection has in most cases been noted, an examination and comparison of their most important features may not be considered to be out of place in this Report.

Norma verticalis.—In most of the skulls, especially the males, the ridge-like elevation in the sagittal region and the slope on each side outwards and downwards to the parietal eminence gave to the cranial vault a characteristic roof-like or ill-filled appearance; which was heightened by the ridge being not unfrequently prolonged forwards in the mid-frontal region. The greatest transverse diameter of the cranial box, both in the males and females, was in the great majority in the region of the squamous suture, and not near the parietal eminences. All the male crania were phænozygous, some slightly so, but others with widely arching zygomata. The females, with two exceptions, were phænozygous. In the youth's crania the zygomata were either invisible or barely visible in the norma verticalis. In the males the stephanic and asterionic diameters were equal or almost equal (within 2 mm.) in eight specimens. The stephanic exceeded the asterionic by more than 2 mm. in six, but was less than the asterionic in the remaining six. In the females the stephanic and asterionic diameters were equal or almost equal (within 2 mm.) in five specimens; the stephanic exceeded the asterionic in three, but was less than the asterionic in the remaining three. In the youth's crania the stephanic exceeded the asterionic by from 1 to 12 mm.

Norma lateralis.—Three of the males rested behind on the tips of the mastoids, one on the occipital condyles, the rest on the conceptacula cerebelli. The females all rested on the conceptacula, and one also on the condyles. The youths' all rested on the conceptacula. In the greater number of this series of skulls, therefore, the cerebellar region of the occipital bone bulged downwards. In the Portland Bay specimens it was almost horizontal, and the inion was brought low down in the occiput. The crania were all elongated. In all the male skulls, with one exception, both the frontal and parietal longitudinal arcs were considerably greater than the occipital; in the exceptional cranium, from Swan Hill, whilst the frontal arc was longer, the parietal was less than the occipital.

In five specimens the frontal and parietal longitudinal arcs were either equal or within 2 mm. of each other; in eight the frontal was in excess, often much greater, than the parietal; in seven the frontal was less, sometimes much less, than the parietal. In all the female skulls, with one exception, the frontal and parietal longitudinal arcs were greater than the occipital; in the exceptional cranium, from New South Wales, whilst the frontal was longer, the parietal was less than the occipital. In three specimens these two arcs were within 2 mm. of each other; in four the frontal arc exceeded the parietal; in four the parietal exceeded the frontal. In all the youths' skulls the occipital arc was less than either the frontal or parietal; in two the frontal was longer than the parietal; in two the parietal was longer than the frontal.

The male crania were, as a rule, massive and heavy, and with strong eminences and ridges at the glabella, supraciliary ridges, external orbital processes, temporal and occipital curved lines. The male skull from the Riverina weighed, with its lower jaw, 2 lbs. 6¾ oz. avoir., and other skulls weighed 2 lbs. and 1 lb. 15½ oz. The adpressed character of the frontal bone above the ectorbitals, in such skulls as those from the Riverina, Eucla, Wannon River, a Queensland and a Murray River skull, was so striking, that in this character and in the projecting glabella they approximated to the well-known skull from the Neander Valley. The very prominent glabella in these specimens contributed materially to the great length, 200 mm., which some of them possessed. On the other hand, the mastoids were not so massive, nor had they such a downward projection as one finds in the male crania of some other races, so that it was the exception for a skull to rest behind on the tips of the mastoids. The projection of the glabella caused a marked depression at the fronto-nasal suture. In the female and young skulls the glabella had so little prominence that the glabello-occipital and ophryo-occipital diameters were either equal or differed but slightly from each other; whereas, in the male skulls they sometimes differed by as much as 4, 5, or even 6 mm. The nasal bones sloped forwards and upwards, were frequently small in size, and the bridge of the nose was concave forwards, usually low, rounded from side to side, and not elevated into a crest. The dimensions of the nasal bones were not taken in all the specimens, but in those that were measured they varied from 18 to 26 mm. in length, and from 6 to 10 mm. in greatest breadth. A very marked slope of the frontal bone upwards and backwards from the glabella was present in many of the male crania. In the female skulls the frontal region was much less sloping, the fronto-orbital region was much smoother and the fronto-nasal less depressed. In a few specimens, *e.g.*, the Wannon river and Eucla crania, the temporal fossa extended so far up the side of the skull that the highest part of the temporal ridge reached to between 3 and 4 cm. from the sagittal suture, and the temporal ridge itself was usually double.

In none of the crania was the nasal spine of the superior maxilla prominent; as a rule, indeed, it was feeble in both the male and female crania. The sides of the anterior nares,

instead of being almost perpendicular to the floor of the nose, and with a sharp edge, were rounded off and smooth where they became continuous with the nasal floor. This form of the anterior nares was especially marked in the skull from Roebuck Bay, in which also the nasal spine of the superior maxillæ was reduced to a faint tubercle. As the obliquity of the sockets of the incisor teeth was great in this skull, the length of the palate and the alveolar prognathism formed marked features in the facial aspect, and the rounded floor and sides of the anterior nares approximated in appearance to the nares of an anthropoid ape. In all the adult skulls, with four exceptions, the width of the posterior nares, measured immediately above the root of the hamular process of the internal pterygoid plate, was less than that of the anterior nares. The interzygomatic breadth invariably exceeded the stephanic, asterionic, and intermalar diameters. Except in one female, the intermalar diameter was greater than the stephanic. In thirteen out of eighteen adult male skulls the interzygomatic diameter exceeded the greatest parieto-squamous; whilst in five out of seven female skulls the inter-parietal exceeded the interzygomatic. The mean interorbital breadth in the males was 24·5 mm., the maximum 28 mm., the minimum 21 mm., whilst in the females the mean was 22 mm., the maximum 25 mm., the minimum 19 mm.

The orbits in the males were characterised both by the massiveness of the upper orbital border and by a peculiar breadth and curvature of the malar bone where it formed the outer boundary, which wanted the sharpness one sees in crania generally, so that in taking the transverse diameter of the orbit there was a difficulty in deciding on the exact point on which the callipers should be placed. In many male skulls the canine fossæ were remarkably deep, although the teeth were not shed, and the hollow was not due to absorption of the jaws from age. These hollows, conjoined with the boss-like supra-orbital and supra-nasal projections, and a sort of general undulatory outline of the orbital boundary, gave to the facial aspect a peculiar rugged and irregular appearance. In the female skulls the external orbital border showed little trace of the peculiarity above described, and the canine fossæ had no special depth.

The crowns of the teeth were large, and the incisors and canines approximated in size; when the cusps were not worn away, the molars were coarsely tuberculated. As a rule the grinding surface of the crowns was flattened from wear, and the dentine more or less exposed. A few teeth were affected with caries, and occasionally a tooth had been shed from age, and the socket absorbed. In a male skull from Queensland, in the Mudgee skull, and in one from the Murray, New South Wales, the left central incisor had been extracted in early life, and its socket absorbed; in a West Australian from Perth, the right central incisor had been similarly treated.[1] This practice of extracting

[1] In some of the skulls subsequently referred to on p. 46 of text a similar peculiarity was observed, viz. in a skull from Rockhampton the right central incisor, in another from the same locality, the left central incisor, and in a skull marked "New Hollander" the right central incisor had been removed.

a central incisor prevails therefore in tribes widely separated from each other, but is by no means general amongst the natives, as none of the other skulls showed it. In the skull from Port Curtis the left lateral incisor had apparently not been developed. In a female from Gipps Land a rudimentary tooth with two small cusps protruded in the dentary arcade behind the left upper wisdom tooth. In a female from Victoria the first premolar was crowded out of its place, and in front of the canine. The palatal tooth in a youth's skull has already been described, p. 30. In many of the crania the maxillary tuberosity had grown into a roughened mass which prolonged the dentary arcade from 1 to 1½ cm. behind the last molar tooth.

In almost all the crania, except those of the youths, there was a tendency to oblitera-

TABLE III.—AUSTRALIAN—MALES.

	Collection,	Chal. Queensland.*	Chal. Queensland.	Port Curtis, Queensland.	Riverina,* N.S.W.	Mudgee tribe, N.S.W.	Macquarrie River, N.S.W.	Swan Hill *b*. N.S.W.	Swan Hill *a*. N.S.W.	Wannon River, Victoria.	Portland Bay, Victoria.
	Age,	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Aged.
	Sex,	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.
	Cubic capacity,	1360	1283	1514	1297	1132	1210	1365	1318	1192	1250
	Glabello-occipital length,	189	193	198	200	182	187	190	184	192	200
	Ophryo-occipital ,,	186	190	196	195	180	185	189	181	186	198
	Basi-bregmatic height,	132	135	136	146	135	135	144	134	134	132
	Vertical Index,	*70*	*70*	*69*	*73*	*74*	*72*	*76*	*73*	*70*	*66*
	Minimum frontal diameter,	92	100	108	100	93	90	99	92	90	98
	Stephanic ,,	105	106	120	108	104	108	110	108	104	109
	Asterionic ,,	116	116	115	106	103	110	106	110	105	109
	Greatest breadth,	132*s*	134*s*	136*s*	132*s*	129*s*	129*s*	135*s*	134*s*	124*s*	123*s*
	Cephalic Index,	*70*	*69*	*69*	*66*	*70·5*	*69*	*71*	*73*	*65*	*61·5*
	Horizontal circumference,	540	540	547	545	511	521	532	520	508	540
	Frontal longitudinal arc,	132	143	135	150	133	132	138	123	137	135
	Parietal ,, ,,	141	137	148	140	124	131	116	130	128	130
	Occipital ,, ,,	105	121	111	120	113	110	125	114	105	114
	Total ,, ,,	378	400	394	410	370	373	379	367	370	379
	Vertical transverse arc,	300	304	307	301	282	288	302	290	277	275
	Length of foramen magnum,	35	31	35	31	33	34	37	35	37	37
	Basi-nasal length,	108	97	106	110	100	104	108	104	107	113
	Basi-alveolar length,	107	100	103	114	100	102	104	109	108	117
	Gnathic Index,	*99*	*103*	*97*	*103*	*100*	*98*	*96*	*105*	*101*	*103·5*
	Interzygomatic breadth,	134	130	136	149	134	134	137	144	138	...
	Internalar ,,	122	122	122	135	124	120	122	123	124	120
	Ophryo-alveolar length,	95	84	99	96	88	87	87	83	92	85
	Naso-alveolar ,,	73	62	68	70	64	64	66	63	66	65
	Facial Index,	*70*	*64*	*66*	*64*	*65*	*65*	*63*	*58*	*66*	...
	Nasal height,	50	43	50	47	48	51	51	47	51	47
	Nasal width,	27	26	26	28	22	27	28	26	26	25
	Nasal Index,	*54*	*60·5*	*52*	*60*	*46*	*53*	*55*	*55*	*51*	*53*
	Orbital width,	40	38	41	43	38	39	40	39	42	41
	Orbital height,	33	30	37	33	34	34	36	31	31	30
	Orbital Index,	*95*	*79*	*90*	*77*	*89·5*	*87*	*90*	*79·5*	*74*	*73*
	Palato-maxillary length,	60	59	59	67	58	62	59	61	63	61
	Palato-maxillary breadth,	70	64	66	74	71	66	65	63	66	68
	Palato-maxillary Index,	*117*	*108*	*112*	*110*	*122*	*106*	*110*	*103*	*105*	*111*
Lower Jaw.	Symphysial height,	35	...	...	36	34	30	30	...	...	33
	Coronoid ,,	69	...	...	78	66	61	64	...	...	57
	Condyloid ,,	60	...	...	73	60	62	62	...	...	58
	Gonio-symphysial length,	105	...	...	107	92	91	91	...	...	98
	Intergonial width,	102	...	...	113	91	94	103	...	...	100
	Breadth of ascending ramus,	39	...	...	43	39	39	37	...	...	43

* With pelvis.

tion of the sutures of the cranial vault, the degree to which this had taken place varying in different specimens. The tendency to bone formation in these Australian skulls, which gave rise to their weight and other peculiarities, affected also the condition of the sutures, so as to occasion obliteration at an earlier age than is the case in European skulls. No skull was metopic, but in the male youth indications of a frontal suture traversing the glabella were seen. Small Wormian bones were present in the lambdoidal suture in a few skulls, but there was no example of an interparietal bone. In several crania the spheno-parietal articulation was reduced to less than 5 mm. In three the squamous-temporal and frontal articulated directly at the pterion, either on one or both sides; in

TABLE IV.—AUSTRALIAN—MALES.

	Collection,	Benalla, Vict.	Hobson's Bay, Viet.	Fowler's Bay, S. Aust. Aet. 40	South Australia Coorong tribe.	Alexandra Land.	Eucla,* W. Aust.	Perth,* W. Aust.	Cape Leeuwin. W. Aust.	De Grey River, N.W. Aust.	Roebuck Bay, Lat. 18°.
	Age	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.
	Sex,	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.
	Cubic capacity,	1270	1336	1235	1400	1218	1334	1310	1356	1450	1044
	Glabello-occipital length,	183	190	190	200	187	200	189	194	198	180
	Ophryo-occipital ,,	181	188	188	196	182	197	185	191	197	178
	Basi-bregmatic height,	136	137	134	131	130	136	134	136	134	130
	Vertical Index,	*74*	*72*	*70*	*65*	*69*	*68*	*71*	*70*	*68*	*72*
	Minimum frontal diameter,	96	100	103	102	99	104	104	102	102	95
	Stephanic ,,	116	115	115	113	105	109	113	113	112	100
	Asterionic ,,	107	108	112	114	110	116	110	120	112	110
	Greatest breadth,	133*s*	136*s*	129*s*	137*s*	132*s*	132*s*	137*p*	134*s*	134*s*	122
	Cephalic Index,	*73*	*72*	*63*	*68·5*	*71*	*66*	*72·5*	*69*	*68*	*68*
	Horizontal circumference,	522	537	527	560	515	560	530	537	550	500
	Frontal longitudinal arc,	128	135	133	134	128	132	131	133	138	127
	Parietal ,, ,,	137	132	135	138	123	132	134	133	148	126
	Occipital ,, ,,	109	108	107	124	113	119	119	107	114	111
	Total ,, ,,	374	375	375	396	364	383	384	373	400	364
	Vertical transverse arc,	296	292	290	295	283	287	294	298	292	274
	Length of foramen magnum,	34	31	36	33	33	39	31	38	33	29
	Basi-nasal length,	102	111	106	105	106	109	102	112	105	100
	Basi-alveolar length,	108	108	105	109	106	106	102	108	105	108
	Gnathic Index,	*106*	*97*	*99*	*104*	*100*	*97*	*100*	*96*	*100*	*108*
	Interzygomatic breadth,	...	135	136	139	138	146	134	144	136	120
	Intermalar ,,	123	124	128	128	121	135	120	129	124	112
	Ophryo-alveolar length,	91	96	87	95	86	91	89	80	84	93
	Naso-alveolar ,,	68	74	66	70	66	71	66	60	60	71
	Facial Index,	...	*71*	*63*	*68*	*62*	*62*	*66*	*55*	*62*	*77*
	Nasal height,	48	56	49	51	48	51	50	48	47	55
	Nasal width,	29	27	25	28	27	26	25	26	26	28
	Nasal Index,	*60*	*48*	*51*	*55*	*56*	*51*	*50*	*54*	*55*	*51*
	Orbital width,	41	40	40	42	40	46	41	41	42	38
	Orbital height,	32	35	33	38	31	33	30	30	32	32
	Orbital Index,	*78*	*87·5*	*82·5*	*90·5*	*77·5*	*72*	*73*	*73*	*76*	*84*
	Palato-maxillary length,	65	61	62	66	62	63	58	59	64	68
	Palato-maxillary breadth,	66	70	63	65	69	70	65	66	69	68
	Palato-maxillary Index,	*101·5*	*115*	*102*	*98·5*	*111*	*111*	*112*	*112*	*108*	*100*
Lower Jaw.	Symphysial height,	32	33	...	34	36	32	32	32	31	33
	Coronoid ,,	68	63	...	71	66	68	64	62	67	65
	Condyloid ,,	68	59	...	65	55	63	62	56	57	64
	Gonio-symphysial length,	105	98	...	97	91	103	87	101	91	97
	Intergonial width,	105	103	...	97	91	101	86	98	88	91
	Breadth of ascending ramus,	41	39	...	37	35	40	38	42	38	...

* With pelvis.

two there were small epipteric bones. In a youth's skull from the Murray River the antero-inferior angle of the parietal was very elongated, and the parieto-sphenoid suture was only 4 mm. broad. In a male two small ossicles were in the palato-maxillary suture. Faint indications of a maxillo-premaxillary suture were occasionally seen on the palatal surface. The malar bone was not divided in any specimen. In one youth's skull, although the basi-cranial synchondrosis was open, one of the styloid processes was ossified to the temporal bone.

The vertical diameter of the os planum was in several instances short, and in the Cape Leeuwin, Roebuck Bay, Gipps Land, and Alexandra Land skulls, this part of the ethmoid terminated in a point anteriorly, so that the ethmoid and lachrymal barely

TABLE V.—AUSTRALIAN—FEMALES.

	Collection	E.U. A.M. N.S.W.	E.U. A.M. No. 67. N.S.W.	N.S.W. No. 1.	Lower Murray, N.S.W.	Gipps Land. No. 1.	Gipps Land. No. 2.	Gipps Land. No. 3.	Benalla, Vict.	Portland Bay, Vict.	Chal. West* Vict.	Lake Alex., S. Aust.
	Age,	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad	Ad.
	Sex,	F.	F.	F.	F.	F.	F.	F.	F.	F.	F.	F.
	Cubic capacity,	1088	930	1146	1098	1156	1140	...	1115	946	1192	1220
	Glabello-occipital length,	184	164	181	176	180	182	173	184	176	172	180
	Ophryo-occipital ,,	184	164	181	175	180	182	171	182	174	172	178
	Basi-bregmatic height,	122	110	128	128	124	123	...	130	122	124	130
	Vertical Index,	*66*	*67*	*71*	*73*	*69*	*67*	...	*71*	*69*	*74*	*72*
	Minimum frontal diameter,	96	84	92	93	94	90	93	98	86	88	94
	Stephanic ,,	103	98	106	107	107	99	102	110	95	100	105
	Asterionic ,,	106	94	100	104	107	108	103	108	95	104	105
	Greatest breadth,	130*s*	118*s*	130*s*	125*s*	132*s*	132*s*	128*s*	124*s*	119*s*	134*s*	131*s*
	Cephalic Index,	*71*	*72*	*72*	*71*	*73*	*72·5*	*74*	*67*	*68*	*78*	*73*
	Horizontal circumference,	510	455	500	493	501	505	488	502	484	488	508
	Frontal longitudinal arc,	125	113	126	126	122	113	118	121	117	119	124
	Parietal ,, ,,	121	116	114	121	128	128	120	120	119	126	120
	Occipital ,, ,,	110	111	120	110	110	112	...	113	104	105	111
	Total ,, ,,	356	330	360	357	360	353	...	354	340	350	355
	Vertical transverse arc,	268	254	282	275	274	275	278	273	253	280	278
	Length of foramen magnum,	36	28	30	31	34	35	...	35	33	36	34
	Basi-nasal length,	98	85	100	93	95	101	...	108	95	94	101
	Basi-alveolar length,	...	88	92	92	94	99	...	110	100	90	104
	Gnathic Index,	...	*103·5*	*92*	*99*	*99*	*98*	...	*102*	*105*	*96*	*103*
	Interzygomatic breadth,	...	...	121	116	127	...	...	125	124	124	130
	Intermalar ,,	...	...	109	104	115	112	...	116	114	106	116
	Ophryo-alveolar length,	...	70	81	75	73	82	...	82	89	82	90
	Naso-alveolar ,,	...	52	61	55	56	62	...	62	69	59	66
	Facial Index,	...	...	*67*	*64*	*67*	...	...	*65*	*72*	*68*	*69*
	Nasal height,	...	37	43	43	43	51	...	47	48	44	49
	Nasal width,	...	22	26	25	24	25	...	24	24	23	25
	Nasal Index,	...	*59·5*	*54*	*58*	*56*	*49*	...	*51*	*50*	*52*	*51*
	Orbital width,	...	34	35	38	39	41	...	39	38	36	37
	Orbital height,	...	29	33	35	32	37	...	33	36	33	35
	Orbital Index,	...	*85*	*94*	*92*	*82*	*90*	...	*85*	*95*	*92*	*95*
	Palato-maxillary length,	...	50	51	50	54	54	...	61	57	48	60
	Palato-maxillary breadth,	...	53	60	54	62	61	...	64	62	55	68
	Palato-maxillary Index,	...	*106*	*118*	*108*	*116*	*113*	...	*105*	*109*	*114·5*	*113*
Lower Jaw.	Symphysial height,	...	...	25	...	...	...	...	...	28	25	29
	Coronoid ,,	...	...	50	...	...	...	...	...	56	50	61
	Condyloid ,,	...	...	45	...	...	...	...	...	52	54	57
	Gonio-symphysial length,	...	..	85	...	...	...	...	...	86	83	89
	Intergonial width,	...	...	88	...	...	...	...	...	91	82	86
	Breadth of ascending ramus,	...	...	32	...	...	...	...	...	30	...	38

* With pelvis.

articulated with each other, and the orbital plates of the frontal and superior maxilla were almost in contact. The occurrence of this arrangement in the Roebuck Bay skull added another to the ape-like characters of this cranium referred to on p. 32. In the Perth skull the orbital surfaces of the two lachrymals were remarkably small, the maximum length being 11 mm. and the breadth 6 mm. In three males and one female the anterior palatine foramen was unusually large, reaching 5 mm. in its transverse

TABLE VI.—AUSTRALIAN—YOUNG SKULLS.

	Collection,	Murray, N. S. W.	N. S. W. No. 2.	N. S. W.	Lower Murray, N. S. W.
	Age,	Aet. 16.	Aet. 16.	Aet. 18.	Aet. 18.
	Sex,	M.	M.	F.	F. (?)
	Cubic capacity,	1295	1252	1066	1265
	Glabello-occipital length,	188	183	182	182
	Ophryo-occipital „	187	181	180	182
	Basi-bregmatic height,	128	129	133	131
	Vertical Index,	*68*	*70·5*	*73*	*72*
	Minimum frontal diameter,	98	90	98	91
	Stephanic „	109	108	112	108
	Asterionic „	108	104	100	103
	Greatest breadth,	129*s*	127*p*	127*p*	131
	Cephalic Index,	*69*	*69*	*70*	*72*
	Horizontal circumference,	520	504	502	501
	Frontal longitudinal arc,	134	129	135	127
	Parietal „ „	133	120	141	130
	Occipital „ „	121	112	104	116
	Total „ „	388	361	380	373
	Vertical transverse arc,	281	283	289	283
	Length of foramen magnum,	31	31	32	29
	Basi-nasal length,	95	102	95	100
	Basi-alveolar length,	95	106	98	100
	Gnathic Index,	*100*	*104*	*103*	*100*
	Interzygomatic breadth,	120	118	...	117
	Intermalar „	108	106	109	104
	Ophryo-alveolar length,	72	80	77	78
	Naso-alveolar „	52	61	70	63
	Facial Index,	*60*	*68*	...	*67*
	Nasal height,	40	45	49	46
	Nasal width,	21	21	24	29
	Nasal Index,	*52·5*	*47*	*49*	*63*
	Orbital width,	38	37	38	37
	Orbital height,	30	32	31	32
	Orbital Index,	*79*	*86·5*	*82*	*86·5*
	Palato-maxillary length,	53	58	60	55
	Palato-maxillary breadth,	65	62	65	64
	Palato-maxillary Index,	*123*	*107*	*108*	*116*
Lower Jaw.	Symphysial height,	...	28	28	28
	Coronoid „	...	53	53	52
	Condyloid „	...	46	51	45
	Gonio-symphysial length,	...	86	80	83
	Intergonial width,	...	84	...	85
	Breadth of ascending ramus,	...	38	34	29

diameter. I did not see in any of the crania an exostosis within the external meatus; a third occipital condyle; a paramastoid process, except in the most rudimentary form; or a complete pterygo-sphenoid foramen, although in a Swan Hill skull such a foramen was almost formed. In several specimens a suture extended from the infra-orbital foramen through the lower border of the orbit into the infra-orbital canal.

The lower jaw was not so strongly developed as might have been expected from the massiveness of the skull generally. In the Riverina and some other males the rami were large, the angle almost rectangular, and the chin square; but the mental region was often feeble and with scarcely any forward projection at its lower border. The inter-gonial width was sometimes greater, at others less than the gonio-symphysial length. The coronoid height was, with few exceptions, greater than the condyloid; the sigmoid notch had not any great depth, though it was not so shallow as in the Bush crania.

The mean cephalic index of the thirty-one adult crania was 70; that of the twenty males was 69; that of the eleven females was 72. Each skull was dolichocephalic, with the sole exception of the female from Victoria presented by Mr. J. Dawson, the length-breadth index of which was 78. Setting this skull on one side, the ten female crania ranged from 74 to 67, whilst the males ranged from 73 to 61·5. The mean cephalic index of the adult females was therefore greater than that of the adult males. The mean length-breadth index of the four youths' crania was 70. A most noticeable feature in these Australian skulls was the great length of so many of the male crania, four of which were each 200 mm. long, and eight others were between 190 and 200 mm. They are indeed the longest normal skulls that have been measured in the course of this enquiry. The adult male from Portland Bay with a length of 200 mm., had a breadth of only 123 mm. All the sutures of the cranial vault were ankylosed, and from the very complete obliteration of the sagittal and the ridge-like elevation of its region, together with the scaphocephalic form of the skull, it is not unlikely that this suture may have been prematurely closed, which would account for the little breadth of the cranium and its abnormally low cephalic index, 61·5.[1] In the male from the Wannon River, with the low index of 65, and in the Riverina skull with an index of 66, there was no premature synostosis, although the sagittal suture was partially obliterated through age. The female skull from Portland

[1] In the Anatomical Museum of the University is a very characteristic adult scaphocephalic skull, which I described and figured in the *Natural History Review*, vol. iv. p. 94, fig. 1, 1864. Its glabello-occipital length was 202 mm., its transverse diameter 130 mm., and its cephalic index 64. The well-known traveller Baron de Miklucho-Maclay describes in the *Proc. Linn. Soc. New South Wales*, vol. viii. p. 401, pl. xix., 1883, a very dolichocephalic skull collected in Queensland, but now in the Australian Museum, Sydney. The cephalic index is 58·3 the vertical index 64·8. The glabello-occipital length is 204 mm; breadth 119 mm.; height 131 mm. He states that the skull shows no evidence of deformity, but in his description and figure he points out that the sagittal suture is completely obliterated. This character combined with the scaphocephalic shape of the skull leads me to think that its length and narrowness were due to premature synostosis of the sagittal suture. Dr. Barnard Davis has also described and figured (*Natuurkund. Verhandel. Holland. Wetensch. Haarlem*, 1865) a very interesting scaphocephalic skull from the Macleay River district, N.S.W., the length of which was 210 mm., the breadth 121 mm., and the height 134 mm. The cephalic index was only 57, and the vertical index was 63. I may also refer to the scaphocephalic skull of an Egyptian mummy described by me in the *Edin. Med.*

Bay, which was only 119 mm. in its parietal diameter, had also a complete obliteration of the coronal and sagittal sutures, and a shape approximating to the scaphocephalic.

The mean vertical index of thirty adult crania was 70·4; that of the twenty males was 70·6, that of ten females was 69·9, so that the difference between the two sexes was very slight. The mean basi-bregmatic height of twenty males was 135 mm.; the minimum in two specimens was 130, the maximum in one 146; in two specimens only the maximum exceeded 140 mm. The mean basi-bregmatic height of ten females was 124 mm.; only two specimens reached 130 mm., and one was as low as 110 mm. The difference, therefore, between the height of the two sexes was very remarkable, andgreatly to the advantage of the males. In eight of the male crania the actual height was either equal to or within 2 mm. of the greatest breadth in the same skull; in nine skulls the height was distinctly greater than the breadth, in two the height was less than the breadth. In the female skulls the height and breadth were almost equal in one specimen; the height was greater than the breadth in three, but less than the breadth in six. Hence in the females it was not only the rule for the basi-bregmatic height to be less than the greatest breadth, but the mean altitudinal diameter was in relation to the length less than the transverse diameter. The skulls were tapeinocephalic.

The mean gnathic index of twenty-nine skulls was 100·3; that of twenty males was 100·6, that of nine females was 99·7; the average for each sex, as well as for both sexes collectively, brought this index into the mesognathous series according to the division employed by Prof. Flower. The maximum index in the males was 108, and seven specimens were 103 or upwards, *i.e.*, had a decidedly prognathous index, whilst eight were mesognathous and five were orthognathous. The maximum index in the females was 105, and three specimens only were 103 and upwards. In the four youths' crania the mean gnathic index was 101·7, being somewhat higher than that of the adults.

The mean nasal index of twenty-nine skulls was 53·4; that of twenty males was 53·47, that of nine females was 53·2. The average for each sex, as well as for the two sexes collectively, was platyrhine. The highest index in the male series was 60·5, and twelve specimens were 53 or upwards; one the Mudgee skull was 46, *i.e.*, in the leptorhine series, whilst seven were mesorhine. The highest index in the female series was 59·5, and four were above 53, whilst the remaining five were mesorhine. The mean of the four youths was 52·9, *i.e.*, on the verge of the platyrhine group.

The mean orbital index was 84; that of twenty males 81·4, that of nine females 90. The average on the two sexes collectively was mesoseme; that of the males microseme, that of the females megaseme. In the males twelve were below 84, *i.e.*, microseme; three were mesoseme, whilst five were megaseme. In the females the whole with one exception were megaseme. The mean orbital index in the youths' crania was 83·5.

Journ., July 1865, the cephalic index of which, calculated on a parietal breadth of 4·3 inches, was only 53, but, calculated on a mastoid breadth of 4·8 inches, was 59.

The mean palato-maxillary index was 109; that of twenty males 108·7, that of nine females 111, so that they were somewhat less dolichuranic than the males. In one male the palato-maxillary length was 1 mm. greater than the breadth, in one the length and breadth were equal, in four the breadth exceeded the length by not more than 3 mm., and in one only was the breadth greater than the length by more than 10 mm. In two females the breadth was only 3 mm. greater than the length, and in one only was the breadth as much as 9 mm. greater than the length. In the youths' crania the mean palato-maxillary index was 113·5. As a rule those crania that possess a low palato-maxillary index have at the same time a high gnathic index. Thus the male Coorong from Adelaide with p. m. index 98·5 has a gnathic of 104; the male from Roebuck Bay with p. m. i. 100 has a gnathic 108; the male from Benalla with p. m. i. 101·5 has a gnathic 106. In these cases a dolichuranic palate is associated with prognathism, and the prognathic condition is largely due to a forward projection of the alveolar border in the incisor region. In all these cases the palato-maxillary region was not only long relatively to its breadth, but its actual length was considerable, and in the Roebuck Bay specimen it reached 68 mm. Some others, however, with long palato-maxillary regions and high gnathic indices, had not such low palato-maxillary indices, owing to the greater breadth of the region, and in these skulls the palate was large in both dimensions. I may especially name as examples the magnificent male skull from the Riverina, the palato-maxillary region of which was 67 mm. long, the gnathic index was 103, and the palato-maxillary was 110; the skull from the de Grey River with a palato-maxillary length 64, a gnathic index 100, and a palato-maxillary index 108. In the Mudgee skull the gnathic index was also 100, but the palato-maxillary index was as high as 122, for the palate was only 58 mm. long, whilst its breadth was 71 mm.—the broadest palate in the series of Australian skulls, except the Riverina specimen. In such cases the degree of prognathism is probably due to some other cause than a mere projection of the alveolar border.

The mean cubic capacity of thirty adult crania was 1230 c.c.; that of twenty males was 1293·7; that of 10 females was 1103; the males ranged from 1514 c.c. to 1044 c.c.; the females from 930 c.c. to 1220 c.c.; the mean of each sex was therefore microcephalic, and only five male skulls exceeded 1350 c.c., the upper limit of the microcephalic series.

The sexual characters were strongly marked in the Australian crania. The much smaller size and capacity of the female skull, its comparative lightness, the feebleness of its ridges and processes, more especially the glabella; its low basi-bregmatic height and the high orbital index, all constituted important features of difference between the female and the male skulls.

These Australian skulls were in their mean proportions dolichocephalic, tapeinocephalic, phænozygous, mesognathic, platyrhine, mesoseme, dolichuranic, and microcephalic.

Since the publication by Blumenbach, in his third and fourth Decades,[1] of figures and

[1] Göttingen, 1795, 1800.

descriptions of the two New Holland skulls which were presented to him by Sir Joseph Banks, and of the description and figures by W. Gibson[1] and Alex. Monro, *tertius*,[2] of the skull of a New Hollander, the craniology of the aborigines of Australia has excited so much attention that a very extensive literature is now in existence. As the task of making an analysis of this literature, of naming the various writers, and of drawing up a comparative description of the skulls of the different tribes that have been examined, has already been so admirably performed by MM. de Quatrefages and Hamy, in the Crania Ethnica it is unnecessary for me to travel over their ground. Since the publication of their chapter on the Australian crania, however, two additional important contributions on the subject have been made by Prof. Flower, viz., the measurements of the skulls in the Museum of the Royal College of Surgeons[3] and a lecture on the Native Races of the Pacific,[4] also some minor papers by other writers, which have given further material for comparison.

It may now, therefore, be useful to compare the general results which I have arrived at from the examination of the Australian crania described in this Report with those of the above eminent craniologists. MM. de Quatrefages and Hamy give 71·19 as the mean cephalic index deduced from eighty-two observations on both male and female skulls (p. 321), many of the measurements of which were not made by themselves, but collected from the writings of their predecessors. They give, however, detailed measurements of thirty-eight skulls, which they divide into two types. The first type, consisting of thirty-one skulls, which represents the ordinary form of Australian cranium, they divide into coast tribes and tribes from the interior. Belonging to the coast tribes were fourteen male skulls, with a cephalic index of 69·89, and ten females with an index of 72·57. Belonging to the tribes of the interior were four males, C. I. 71·2, and three females, C. I. 73·74. The second type they name dolicho-platycephalic, from the length and lowness of the cranium; four male skulls belonging to it had a cephalic index 69·27, and three females, C. I. 72·37. The mean of the entire series of thirty-eight crania was 71·5. Prof. Flower does not propose any division into types of the fifty-four crania the characters of which he has analysed in his Native Races. Forty-nine of these were adults,—twenty-six males, nineteen females, and four doubtful. The male adults had a cephalic index 71·2, the females 72·3, the mean of the series being 71·75. These skulls, with three exceptions, range from 67 to 74, and of the exceptions one has an index of 75, one of 76, and one of 78. It should be remembered, however, that Prof. Flower excludes the glabella in his measurement of the antero-posterior maximum; if this had been included it is probable that one, if not two, of the exceptional crania might have been included with the rest in the dolichocephalic category. He

[1] Dissertatio de forma ossium gentilitia, Edinburgh, 1809.

[2] Outlines of the Anatomy of the Human Body, vol. i. p. 379, pl. xx. fig. 2; vol. iv., Edinburgh, 1813.

[3] Catalogue, Osteological series, 1879.

[4] *Proc. Royal Inst. of Great Britain*, May 31, 1878.

refers also to ten male skulls, which he measured in the Army Medical Museum at Netley, with a mean index of 72, and he lays down the general proposition that the average cranial index of the Australian skull is 72, or slightly less, and that they are therefore to be placed among the most dolichocephalic of races.

The mean cephalic index of the thirty-one adult crania measured in this Report was only 70, that of the twenty males 69; of the eleven females 72, but one of the female skulls had an index of 78, and it may be a question if this woman was of pure aboriginal blood. My average is therefore less than that of the above observers, which is to be accounted for in part by a considerable proportion of my crania possessing so great an antero-posterior maximum, in part by two of the skulls being unusually elongated, apparently by premature sagittal synostosis, but still more by my longest measurement always including the glabella, which formed so marked a projection in the majority of the male skulls, and by including which the dolichocephalic character of the crania is necessarily increased. My observations agree with those of my predecessors in giving to the female Australian skull a higher length-breadth index than to the male skull.

The mean basi-bregmatic height of forty-five specimens (apparently of both sexes) referred to by MM. de Quatrefages and Hamy (p. 323) was 135 mm. The fourteen male skulls of the coast tribes, in their 29th Table, had the same average height, whilst the ten females were only 131; the four males from the interior again were 141, the females 133; whilst of their dolicho-platycephalic group of crania, the four males were only 124 mm., but the three females were 127. They place the mean vertical index of the whole series of forty-five crania at 73·36, whilst that of the series of thirty-eight skulls recorded in their 29th Table is 71·7, the males being 70·3, the females 73·1. I have extracted from Prof. Flower's catalogue the basi-bregmatic height of thirty-nine males and of twenty-four females. The mean height of the former is 133 mm., that of the latter 126·5 mm. Prof. Flower himself places the vertical index in the male skulls at 72, in the female at 71·1, and in the whole series at 71·5; but in the ten male skulls in the Netley Museum the mean is 74.

If the vertical index in my series of crania be compared with that obtained by the above observers, it will be seen to be less than theirs, viz., 70·4 as against 71·7 and 71·5, which is without doubt owing to the glabella being included in my antero-posterior maximum but not in theirs. My observations accord with those of Prof. Flower in giving to the females a less vertical index than to the males, and we are both in marked contrast to the computations of MM. de Quatrefages and Hamy, in whose 29th Table the height index of the females exceeds that of the males in the proportion of 73·1 to 70·3. This statement by the French craniologists is so opposed to the experience of others that one is tempted to ask if in the drawing up of their table some error has not accidentally been made in their computations.

Prognathism, as estimated by the relative proportions of the basi-nasal and basi-

alveolar diameters, is not a necessary condition of the Australian skull. Prof. Flower places (New Cat.) the gnathic index of fifty-one specimens at 103·6 which brings them just within the prognathic division, but in his "Native Races" he states that there is considerable individual variation in these crania, as in five out of forty-two specimens the basi-alveolar diameter was less than the basi-nasal, and in seven specimens these two diameters were equal. The range of individual variation in my series of crania was from 92 in a female to 108 in a male skull, and the mean gnathic index was not so great as in the College of Surgeons specimens, so that the average was mesognathic. In the College of Surgeons series this index in the females was nearly 105, and more than in the males, where it was 103; but in my series the male average of 100·6 was greater than the female average of 99·7.

The mean nasal index obtained by MM. de Quatrefages and Hamy, by Prof. Flower, and by myself, places the Australian skull in the platyrhine division, but whilst the average of thirty-one skulls measured by the first named was 57·9, and that of Prof. Flower was 56·9, my average was considerably lower, only 53·5. Of the twenty-nine specimens which I measured, sixteen were platyrhine, twelve were mesorhine, and one was leptorhine. The presence of a leptorhine nose amongst the Australians is so rare that the authenticity of any specimen possessing this character requires to be well established. Of the authenticity of the skull of the Mudgee tribe, with its nasal index only 46, there can be no question. The circumstances under which it was got are related in the note p. 29, and, moreover, it was one of the skulls from which an incisor tooth had been extracted at puberty. The anterior nares in this specimen were not only narrow in relation to the height, but their absolute width was only 22 mm. The skull of a Hobson's Bay native had also a nasal index of only 48, one from Gipps Land 49, specimens from Perth and Portland Bay of not more than 50, Roebuck Bay 51[1], and all these were genuine Australian crania. Hence individual crania may possess a much lower nasal index than has usually been ascribed to the skulls of this race.

The mean orbital index of thirty-one skulls in MM. de Quatrefages and Hamy's table is 78·81, that obtained by Prof. Flower from fifty-one skulls is 80·9. These observers, therefore, have placed the Australian skull in the microseme series, which corresponds with my measurements of the male skulls; but owing to the megaseme proportions of so large a number of my female skulls, my average of the whole is raised to 84, which brings them just within the mesoseme series. In MM. de Quatrefages and Hamy's table, as well as in my own, the female index is considerably higher than the male, more so indeed than seems to have been obtained by Prof. Flower in his measurements, who in his "Native Races" places the male orbital index at 81·8, and the female at 82·9.

[1] Although the Roebuck Bay skull has a nasal index of only 51, *i.e.*, was mesorhine, yet the width of the anterior nares 28 mm., was only 1 mm. less than the widest of all the crania measured. Its diminished index was therefore due to the height of the nose 55 mm., which, with one exception, reached its maximum amongst the Australians in this specimen.

I am not aware of any other observations than my own on the palato-maxillary index in the Australian skull, which, as is shown on p. 39, is dolichuranic.

In their cubic capacity the Australian skulls are microcephalic. The average obtained by MM. de Quatrefages and Hamy is 1269 c.c., that by Prof. Flower is 1298, and that by myself is 1230; results which closely approximate, and definitely establish the microcephalic character of these people. We are also in accord in placing the capacity of the female skull as distinctly below the male. As far as the capacities of the individual skulls have been recorded, it is clear that not only is the mean of the race a low one, but that individual skulls do not attain a high capacity, such as one sees in the more cultivated races. Thus in Prof. Flower's series, thirty-two of which were gauged, only eight specimens were 1400 c.c. and upwards, and the highest of these was 1460 c.c.; whilst in my series of thirty-four crania, only three specimens were 1400 c.c. or upwards, and the highest of these, a male from Port Curtis, Queensland, was 1514 c.c.

From the above analysis the general characters of the Australian skulls may be summarised as follows:—markedly dolichocephalic, tapeinocephalic, not strongly prognathic, as a rule platyrhine, microseme or mesoseme, dolichuranic and microcephalic.

It is generally admitted that the northern and north-west coasts of Australia have been visited by both the Papuans and the Malays, and it is possible that the Polynesians may also have landed on the north-east coast. It is not unlikely that small colonies of these races may have been established on the Australian sea-board, and that there a certain local intermixture with the aboriginal Australian people may have taken place. Putting aside, however, these local and occasional admixtures, the question has been discussed by various travellers and anthropologists, if the Australians are a homogeneous people, or if the aborigines of the great island-continent consist of more than one race.[1] I need not enter into a full analysis of the evidence which has been advanced on the one side or the other, but may content myself with referring to two or three prominent writers.

Dr. Martin describes[2] from personal observation the natives of the district of Roebuck Bay in the North West, and states that those of the interior excel those of the sea coast in bodily structure. They are more muscular, taller, and apparently more intelligent; the profile more resembling that of a Polynesian than that of an Australian proper. They are however, black, and the hair is in spiral locks about three or four inches in length, wavy-crisp or frizzled, though not strongly, and jet-black. He gives the measurements of one skull, length 7·23 inches, breadth 5·31, facial angle 94°, upper jaw prognathic so as to give a very oblique insertion to the teeth. Dr. Topinard after a comparison of the

[1] In the Journal of the Anthropological Society of London, p. xxxii., published in the *Journ. of Anthrop.*, 1870, is a short report of a communication made by Dr. Carter Blake, from which it would appear that he considered three types of Australian skull to exist. The report is a mere abstract and without detail. See also Mr. Staniland Wake in *Journ. of Anthrop.*, 1871, and *Journ. of Anthropological Instit.*, vol. 1. 1872.

[2] *Journal of Royal Geographical Society*, vol. xxxv. p. 283, 1865.

descriptions of numerous travellers comes to the conclusion[1] that originally two distinct ethnological elements were indigenous to Australia. The one dolichocephalic, tall in stature, with robust and well proportioned bodies, long, straight, and smooth hair, and with the skin chocolate coloured. The other yet more dolichocephalic, of smaller stature and less robust, the skin black, the hair crisp and frizzly, the jaw very prognathic, and of less intelligence than the preceding. He thinks that the pure type of the inferior race is now extinct, but that it is preserved amongst many of the women of the tribes, and that the present people are the result of the crossing of the inferior and superior races.

On the other hand a very competent observer, Mr. R. Brough Smyth,[2] whilst making allowance for the local infusion of Papuan, Malay, or even Chinese blood, states that throughout Australia the natives exhibit a general conformity to one pattern as regards features, colour, and mental characters, so that "a man from Southern Gipps Land would be recognised as an Australian by the inhabitants of Port Essington, and a native of King George's Sound would be surely known if taken to York Peninsula." Prof. Giglioli also thinks[3] that the idea of a woolly haired race in Australia is due to the loose way in which the terms woolly and crisp have been used by explorers who were not anthropologists. With these different views before us, it will not be without interest to examine the collection of crania just described, to see if they present such diversities in form as might fairly be regarded as racial, and at the same time to ascertain what has been said on this matter by preceding craniologists.

Professor Huxley described and figured, about twenty years ago,[4] an Australian skull from Western Port which differed from the majority of Australian crania in being remarkably depressed at the vertex, and at the same time considerably elongated,[5] and he referred to other skulls from South Australia which possessed similar characters. He directed attention to certain features of resemblance between these crania and the Neanderthal skull. In a later work he has figured[6] one of these South Australian crania from near Adelaide (No. 5334 Cat. Roy. Col. Surgeons) and has again called attention to the Australoid character of certain ancient European crania. Prof. Flower in his new catalogue has given some of the dimensions of this Adelaide skull (No. 1072 New Cat.), which, with a length of 190 mm. possesses a cephalic index 70·5 and a vertical index of only 65·3. MM. de Quatrefages and Hamy, in an early fasciculus of the Crania Ethnica, on human fossil races, have discussed at some length (p. 39 *e.s.*) these conclusions of

[1] Étude sur les Races indigènes de l'Australie, *Bull. Soc. Anth.*, Paris, t. xii. p. 211, 1872. Also a critical review on the Australian Races in *Revue d'Anthropologie*, t. i. p. 298, 1872. Also in his Anthropologie, *op. cit.*

[2] The Aborigines of Victoria, London, 1878, vol. i. p. xvii. Mr. Smyth was for many years Secretary of the Board for the protection of the Aborigines.

[3] Viaggio intorno al Globo della corvetta "Magenta," Milan, 1876; quoted by MM. de Quatrefages and Hamy, p. 300.

[4] Man's place in Nature, p. 155, 1863.

[5] Prof. Flower has given in his new catalogue, p. 187, the dimensions of this skull from Western Port, from which it can be seen that the height 131 mm. slightly exceeded the breadth 130 mm. The vertical index was 73·6, the cephalic 73·0. The length was 178 mm.

[6] Prehistoric remains of Caithness, 1866, p. 131, figs. 62–65.

Prof. Huxley's, and agree with him in recognising an elongated and depressed skull as occasionally occurring in collections of Australian crania. This type they say is not widely diffused, and occurs especially in the Adelaide district, although specimens of a similar kind have been procured from other coast tribes. To crania of this type, whether they occur in the Australian or other races, they have given the name of dolicho-platycephalic. In a subsequent chapter (p. 300 *e.s.*), whilst they regard it as undoubted that in some parts of Australia different ethnic types are accidentally juxtaposed, and more or less fused, yet that, judging by the crania, the Australians proper are none the less one race, and that the differences seen in the crania are sexual rather than ethnic.

They give (p. 317) as an illustration of the dolicho-platycephalic type of skull a specimen presented by M. Erklund to the Museum Retzius (type No. 2). It differs, they say, from the ordinary type (No. 1) of Australian skull in having heavier supraciliary ridges, a much more depressed and more receding forehead, in a general flattening of the cranial vault, in a more considerable backward projection of the occiput, in a very abrupt change of curvature above the occipital protuberance, and in the almost complete horizontality of the base. This skull is markedly dolichocephalic. The antero-posterior diameter is 195 mm.; the greatest transverse diameter only 126 mm.; the basi-bregmatic diameter 125 mm. The length-breadth index is 64·6, the vertical index 64·1. They contrast these indices with those of a skull belonging to the ordinary Australian type, No. 1, in which they are respectively 67·0 and 73·19.

Prof. Flower in his Native Races refers to the collection of the College of Surgeons as containing a number of skulls belonging to a tribe from the neighbourhood of Adelaide of exceptionally depressed form, and in his Catalogue he gives their measurements as well as those of the other skulls in that collection. I have analysed his measurements of the Australian skulls, so far as regards the relative proportions of the cephalic and vertical indices, and find that of the sixty-four specimens, twenty-eight, viz., eleven males and seventeen females, had the vertical index less than the cephalic; six, viz., four males and two females, had their indices equal; whilst in thirty crania the vertical index was greater than the cephalic, and of these, twenty-two were probably males and eight females.

In the Thesaurus Craniorum and Supplement thereto by the late Dr. Barnard Davis,[1] the cephalic and vertical indices of the Australian skulls in his collection are recorded. I find that, after discarding those whose form had been altered by synostosis, or whose authenticity was somewhat doubtful, there remain twenty crania in which the relations of breadth and height to the length are stated. Of these seven, viz., five males and two females, had the vertical index less than the cephalic; in one, a female, the two indices were equal; and in the remaining twelve, eleven males and one female, the vertical index was greater than the cephalic.

[1] London, 1867 and 1875.

Since the previous part of this Report on the Australian skulls was in type, I have had the opportunity of examining fourteen additional Australian adult crania, seven of which were males, four females, and three doubtful, though probably females. These specimens, so far as the localities were known, were from Curtis Island, Moreton Bay, and Rockhampton in Queensland, from the neighbourhood of Sydney and Maitland in New South Wales, from the interior of South Australia and from the Milang tribe, Lake Alexandrina district.[1]

When these specimens are included along with the thirty adult skulls, the length, breadth, and height measurements of which are recorded in Tables III., IV., and V., my own observations extend to forty-four crania, which when analysed give the following results as regards the proportion between the cephalic and vertical indices in the two sexes. Fourteen, viz., four males and ten females, had the vertical index less than the cephalic; seven, viz., six males and one female, had these two indices equal; and twenty-three, viz., seventeen males and six females, had the vertical index greater than the cephalic.

By combining the measures which MM. de Quatrefages and Hamy have themselves made, those contained in Dr. Barnard Davis's collection, those recorded by Prof. Flower in his Catalogue, and the forty-four specimens measured by myself, a series of about one hundred and fifty Australian crania, derived both from the extensive coast-line and the interior of that great island-continent, is before us, from which the following conclusions may be drawn as to the relations of length, breadth, and height in the two sexes.[2]

In fifty-one specimens the vertical index was less than the cephalic, and of these twenty-one were probably males and thirty females; in fifteen these two indices were equal, and of these eleven were probably males and four females; in eighty-five the vertical index was greater than the cephalic, and of these sixty-seven were probably males and eighteen females.

As the localities from which one hundred and twenty-nine of the above crania were derived are known, it is now possible to form a general conclusion as to the parts of Australia in which the crania have a tendency to possess a vertical index below the cephalic, *i.e.*, to show dolicho-platycephalic proportions.

[1] These specimens are either in the Phrenological Museum in this city, in the collection of Dr. Arthur Mitchell, or have been recently presented to the Anatomical Museum of the University. A specimen, a male, from the Milang tribe of South Australia in the Lake Alexandrina district, 50 miles south-east of Adelaide, presented by Mr. R. S. Rogers, is especially interesting. It is a characteristic dolicho-platycephalic skull, length 191 mm., height 125 mm., breadth 130 mm. The vertical index is 65, the cephalic index 68. The glabella and supra-orbital borders are massive and projecting. The face was unfortunately injured, so that the orbital and nasal indices can only be given approximately as 72 and 56, *i.e.*, microseme and platyrhine. The gnathic and palato-maxillary indices could not be obtained.

[2] Dr. Lucæ has given in his Morphologie der Rassen-Schädel measurements of six Australian crania from the Clarence River district in the northern part of New South Wales, but his measurements cannot be combined with the above, as they were made by a different method. Dr. Schaaffhausen has, however, remeasured these and the other crania in the Senckenberg Museum in Frankfurt (*Archiv für Anthropologie*, Bd. xiv., Sup. 20, 1883), in which there are now seven skulls from the Clarence River. The five males and one female all possessed a greater height than breadth, the respective measurements being H. 140, B. 126; 136, 131; 140, 128; 132, 128; 136, 122; 129, 124. One female, on the other hand, was not so high as broad, the measurements being H. 123, B. 128.

Twenty specimens were from North Australia. Of these in only two, a female from Cape York, and a male from Alexandra Land, were the vertical indices less than the cephalic, in another, a female from Port Essington, these two indices were equal, but in the remaining seventeen from Cape York, Arnhem Land, Camp in Heaven,[1] Raffles Bay, and Port Essington the vertical index exceeded the cephalic, and of these, thirteen were probably males and four females.

Three specimens were from North-west Australia. In none was the vertical index less than the cephalic; in one, a male, from the De Grey river, these indices were equal; in one from Roebuck Bay and in one from Dampier Land, both of which were probably males, the vertical index exceeded the cephalic.

Twenty-one specimens were from Queensland. In none was the vertical index less than the cephalic. In four, two males and two females, these indices were equal, and of these one was from Port Curtis, and another from Curtis Island (lat. 23°, long. 151°). In seventeen, all apparently males, the vertical index was greater than the cephalic, and these were from Moreton Bay, Rockhampton, and the interior of the colony.[2]

Twenty-six specimens were from New South Wales. Seven of these, two males and five females, had the vertical index less than the cephalic, one was from Bathurst, one from the coast near the southern part of the colony, and the rest from parts of the colony not exactly specified. In three males from Swan Hill, Port Jackson, and the Murrumbidgee these two indices were equal. In sixteen, nine males and seven females, the vertical index was greater than the cephalic; these specimens were from the Riverina, Mudgee, Macquarrie, Swan Hill, Lower Murray, Maitland, M'Leay, Port Stephen, and Sydney districts.

Nine skulls were from West Australia. One, a male, from Perth, had the vertical index less than the cephalic; two males from King George's Sound and Swan River had these indices equal; five males and one female from Eucla, Cape Leeuwin, King George's Sound, and Swan River had the vertical index greater than the cephalic.

Victoria furnished twenty-eight crania. In six, two males and four females, the vertical index was less than the cephalic, and these skulls came from Gipps Land, Western Victoria, Lake Timboon, and Port Fairy. In one, a male, from Hobsons Bay, these two indices were equal. In twenty-one specimens, fourteen males and seven females, from Port Philip, Western Port, the Murray, Port Fairy, the Upper Yarra, the neighbourhood of Melbourne, Piccaninny Creek, Gobo Island, Lake Timboon, Benalla, and the Wannon River, the vertical index exceeded the cephalic.

[1] I give this locality on the authority of MM. de Quatrefages and Hamy. I have not been able to find the name marked on any map to which I have had access.

[2] In addition to the specimens from Queensland referred to in the text, I may state that ten skulls, all with one exception, from Bowen in that colony, are in the Godeffroy Museum, Hamburg. I observe from Dr. Krause's measurements that in six males and three females, the height is greater than the breadth, and in one female only is the reverse to be noted, the breadth in that specimen being 133 mm., the height 130 mm.

South Australia proper contributed twenty-two crania. Of these, seventeen specimens had the vertical index less than the cephalic, viz., ten males and seven females; the crania came from the neighbourhood of Adelaide, Port Augusta, Lake Alexandrina, the Milang tribe, and the Coorong tribe. Two, a male and a female, had the cephalic and vertical indices equal. In three males, from Fowlers Bay, Adelaide, and Port Augusta, the vertical index was greater than the cephalic.

It would appear, therefore, that in this large and varied series only two skulls occurred, collected to the north of the latitude of the southern boundary of Queensland, viz., a female from Cape York, and a male from Alexandra Land, in which the vertical index was less than the cephalic. On the other hand, from south of that latitude, a considerable number of crania possessing this character have been obtained. Victoria, N. S. Wales, and South Australia proper, but more especially the last named, have furnished the greater number. But along the whole southern seaboard, from Perth on the west to Gipps Land on the east, and more particularly in the district near Adelaide, dolicho-platycephalic skulls have been procured. The proportion which South Australia has furnished is so large that, of the twenty-two skulls from that colony, seventeen had the vertical index less than the cephalic, and two others had these indices equal.[1]

The question therefore now arises, is this difference in the relations of the two indices so marked and so constant that the people in whom it is found are either to be regarded as a race differing from those who do not possess this character, or that it is merely sexual. As regards its relation to the two sexes, it was not limited to the one or the other. Of the series of thirty-three crania exhibiting this character, probably seventeen were males and sixteen females, and in the South Australian group of these, ten were males and seven females. It is therefore so nearly equally manifested in the two sexes, that it cannot be said to distinguish one sex more than the other. It is more difficult to pronounce definitely as to its value in the discrimination of racial differences. Its great relative frequency in the tribes of the southern seaboard points to the conclusion that, in the natives of this part of the coast-line, a genetic tendency existed to develop skulls exhibiting this character.

But it would not be safe to state that, because of this difference in the single character of the relation of the breadth to the height of the skull, those with a vertical index lower than the cephalic were therefore of a different race from those whose vertical index was higher. And this the more so when we find that the relations of breadth and height are not constant in the people of the same district. Thus, of the four

[1] Since the above was written I have read M. Cauvin's paper in the *Bull. de la Soc. d'Anth. de Paris*, March 1883, on the races of Oceania, in which he argues that, owing to diversities in the details of structure in the Australian skulls, that race is not pure but mixed. He gives a table of the cephalic, nasal, and orbital indices of fifty-two crania from different parts of the island, but he does not refer to the height index, so that I cannot utilise his table in connection with the question of dolicho-platycephalism. Some of the skulls he has measured are mesaticephalic, others brachycephalic.

skulls from Adelaide in the Barnard Davis collection, whilst three had the vertical index less than the cephalic, in the fourth the height was greater than the breadth; of the two skulls from the same burial-ground near Port Augusta, in the Museum of the College of Surgeons, one had its vertical index less, the other greater than the cephalic; of the four skulls from Port Fairy in the same Museum, three had the vertical index less, the fourth greater than the cephalic.

The strongly projecting supraciliary ridges and glabella, which have also been described as characteristic features in the dolicho-platycephalic crania, are by no means confined to them. The skulls of the Milang and Coorong tribes, markedly dolicho-platycephalic, have undoubtedly massive ridges in the supra-orbital and supra-nasal regions, but other Australian skulls, in which the height considerably exceeded the greatest breadth, possessed this character in as great, if not a greater degree. Of the skulls which I have myself examined, the Riverina, Eucla, and Wannon River crania may be again referred to as exhibiting this character in a remarkable manner. The Riverina skull is probably one of the most massive in this region in any collection of Australian skulls, and yet, as may be seen in Table III., its height exceeded its greatest breadth by 14 mm. The dolicho-platycephalic cranium is not necessarily associated with great gnathic projection, for although in the skulls of the Coorong and Lake Alexandrina tribes, and in one from New South Wales (No. 67), the gnathic index was 103 or upwards, yet in another dolicho-platycephalic cranium from New South Wales (No. 1), and in two from Gipps Land, this index was below 100. Again, in Australian crania the height of which distinctly exceeded the breadth, as in a Queensland, the Riverina and Roebuck Bay specimens, a high gnathic index was found, that of the last named skull being 108. Neither does there seem to be any definite relation between dolicho-platycephalism and the nasal index, for although the Coorong, Lake Alexandrina, and Milang skulls, all from tribes in close proximity to each other, were distinctly platyrhine, the index of the Perth skull was 50, and in one of the Gipps Land specimens only 49, although in the other it was 56. On the other hand, amongst non-dolicho-platycephalic crania, as in a Queensland, the Riverina and Benalla specimens, the platyrhine index rose to 60.

As regards such physical characters as can be determined by an examination of the external form and general appearance of the natives, there does not appear to be any very definite evidence of the co-existence of two distinct races. In corroboration of the statement of Mr. Brough Smyth already quoted (p. 44), I may also refer to a short article on the Aborigines of South Australia by Mr. J. D. Woods,[1] in which he says that the same description will apply to the natives all around the coast-line. This probable homogeneousness of race is also borne out by a general uniformity of customs, laws, and weapons. So little is known of the Roebuck Bay natives, where Dr. Martin considered important differences to exist between the coast and interior tribes, that no definite opinion of the

[1] *Trans. and Proc. of Phil. Soc. of Adelaide, South Australia*, p. 81, 1878-9.

people in this locality can be arrived at. So far as I know, only one skull from this district is in any collection, and although, as I have pointed out in this Report, it presents certain remarkable characters, yet as there is only one specimen I am not prepared to say that they are anything more than individual peculiarities.

The evidence afforded by the study of the skulls of the Australians does not therefore appear to me to sustain the view that two or more distinct races of aborigines, since the discovery of Australia by Europeans, have been or are now living side by side. In no series of crania from one locality do we find such a combination of characters so marked as to differentiate them from the natives of another locality. The fact, however, that in South Australia proper, and in other places, more especially along the southern seaboard, there is a special tendency for the crania to possess a height index distinctly below that of breadth, would perhaps justify the inference that amongst those tribes an intermixture may at some previous time have taken place with a people in whose crania the height index was normally below that of the breadth, and that in proportion to the extent of this intermixture did this modification in the cranial indices show itself.

In connection with this I may refer to the relations of length, breadth, and height in the skulls of the now extinct Tasmanians, a people who, from their geographical position, and from the fact that they had constructed and attained considerable proficiency in the use of both canoes and rafts,[1] may at an early period of their unwritten history have migrated across Bass Strait. MM. de Quatrefages and Hamy in their twenty-first Table give the measurements of five Tasmanian men and three women. In the men the mean vertical index was 71·6, in the women 68·9, whilst the cephalic index in the men was 77·7 and in the women 75·2. Prof. Flower gives the measurements of the Tasmanian crania in the Museum of the College of Surgeons, and places the cephalic index of fourteen skulls at 76·3, and the vertical index of the same number at 72·6. In both these series therefore, the vertical index is much below the cephalic. But there is this important difference between the Tasmanians and the Australians, viz., the much higher cephalic index of the former, so that in their relation of length and breadth they are mesaticephalic. It is possible that the Tasmanians may have at a remote period occupied the southern part of Australia, and have been displaced by the present Australian race, but that an intermingling of the two races may have occurred along the southern sea-board.

On the other hand New Guinea and other islands to the northward are inhabited by a dolichocephalic race, whose crania, as will be described in subsequent pages, have a vertical index distinctly above the cephalic, and as they are a seafaring people, it is not unlikely that an infiltration of Papuan blood amongst the Australians may have taken place.

[1] See Mr. Brough Smyth's account of the Aborigines of Tasmania in vol. ii. of the Aborigines of Victoria, already cited.

ADMIRALTY ISLANDERS.

Plates III., IV., V., VI. Tables VII., VIII., XVIII., XIX.

The skulls from the Admiralty Islands were the most valuable part of the craniological collection, as apparently no Europeans had landed on these islands prior to the visit of H.M.S. Challenger, and skulls of the natives were unknown in our museums. They were collected in March 1875, in villages on the coast of Wild Island, one of the small islands off the north-western end of the main island, whilst the Challenger lay at her anchorage in Nares Harbour.

An interesting account of the physical characteristics of the inhabitants of these islands has been published by H. N. Moseley, Esq., one of the naturalists to the Expedition,[1] and as it will be useful to bring his description alongside of that which I am about to give of the crania, I reproduce it here.

TABLE VII.—"*Physical characteristics.*—The following measurements were taken:—

MEASUREMENTS in inches of NATIVES of the ADMIRALTY ISLANDS, taken by the late R. VON WILLEMOES SUHM, being of NATIVES of WILD ISLAND, except 6, 7, 8, 9, taken on board the ship by VON SUHM and H. N. MOSELEY.

		Height.	Breadth.	Arm Length.	Leg Length.	Foot Length.	Hand Length.	Nose Length.	Forehead Length.	Ear Length.	Breasts Length.		
WOMEN.	1. Old woman; 40 years ca.,	60	15	28	...	10	7	...	...	...	7		
	2. Young girl; 15 years ca.,	61½	15	25	33	9½	...	1⅞	...	2½	...		
	3. Older women of mean size,	60	12	25	...	9	6⅞	2	3	...	6½		
	4. Old female,	63	...	...	...	10	8	...	...	...	...		
	Mean,	61	14	26	33	9½	7½	2	3	2½	6¾		
											Mouth Length.	Penis Length.	Weight in lbs.
MEN.	1. Young man,	67	16	29	37	9½	7	2	2	2¼	2⅝	...	...
	2. Adult,	63	18	28	35	10½	7	2⅜	3	2⅞	...	...	...
	3. Adult,	63	17½	27½	34	9½	...	2	...	2½	3⅛	...	...
	4. Adult,	66	17½	28½	...	...	...	...	...	2⅛	...	...	...
	5. Oto,	67	17½	...	...	...	...	...	...	...	...	...	...
	6. Adult,	64¾	...	...	...	...	...	...	...	...	...	...	122
	7. Adult (photographed),	63	...	...	...	9¾	...	...	...	...	...	...	...
	8. Adult,	62½	17¼	27½	33½	10¼	8	1⅞	3	3	3	3	133
	9. Young man,	66¾	16	27	34	10	7½	2	3¾	...	...	3½	126
	Mean,	64⅞	17 1/7	28	34⅗	9⅝	7½	2	3	3	3	3¼	127

[1] On the Inhabitants of the Admiralty Islands, *Journ. Anthrop. Inst.*, May 1877

"Further measurements of numbers 8 and 9.—8, girth of chest with arms held up, 36; 9, girth of chest, 33. Breadth of foot just behind origin of toes 14½. Girth at umbilicus, 30. Round buttocks, 34.

"Two heights of adult men taken by me, 68 and 60¾ inches.

"The measurements of the legs were taken from the great trochanter of the femur to the sole of the foot. Those of the breadth from tip to tip of clavicles. Those of the hand from the inner margin of the palm to the tips of the middle finger. Those of the forehead from the root of the nose to the commencement of the hair. The chest girth measurements were taken with the arms upheld.

"Average specimens were selected by von W. Suhm as far as possible. The mean height of the men, as will be seen from the table, is about 5 feet 5 inches. Whilst the tallest man measured was 5 feet 8 inches, and an unusually short one only a fraction over 5 feet, the mean height of the women is 5 feet 1 inch.

"It is difficult, and possibly of little value, to compare the measurements here obtained with those given in the Anthropological part of the 'Novara' publications, vol. iii., since the methods of measurement differ widely. I have, however, by adding together the lengths there given separately for fingers, hand, forearm, and arm, and treating this as the length of the arm, obtained the ratio of the length of the body to the length of the arm in several races, and compared it with the similar ratios in the case of the Admiralty Islanders, using the averages of the measurements where available. The results are shown in the following table:—

	Measurements in Millimetres.		
	Height.	Length of Arm.	Ratio of Height to Length of Arm.
New Zealanders, men,	1757	859	2·04
Australian men,	1675	819	2·04
Australian women,	1596	770	2·07
Tahitian women,	1614	772	2·09
German men,	1680	789	2·1
German women,	1544	713	2·1
Admiralty Island men,	1646	711	2·30
Admiralty Island women,	1549	660	2·30

"Whence it appears that the Admiralty Islanders are short armed.

"The race is of average height, but the weight is, as usual with savages, below that of Europeans; 126 lbs (nine stone), as compared with 150 lbs, about the weight of an average Englishman. The natives contrasted at first glance with the Papuans of Humboldt Bay in being far thinner and lankier. I saw but one native that was at all fleshy, although such were not uncommon at Humboldt Bay. The usual colour of the natives is a black-brown, often very dark, and darker than that of the Papuans of Humboldt Bay. The young girls and young boys appear much lighter as a rule than the adults. Some one or two of the younger women were of a quite light yellowish-brown, as was also one young man who came from a distance to the ship to trade. I saw no old women who were light coloured.

"The arms and legs of the men are covered with a short, sparse, curly black hair, which appears as

if growing in separate locks,[1] exactly as in the Humboldt Bay natives. Hair is rarely present in any quantity on the back or chest, but in a few exceptionally hairy examples it was well marked.

"The hair of the head, which is worn long only by the younger adult males, formed in them a dense mop, projecting in all directions 6 to 8 inches from the head. It appeared less luxuriant in growth than that of the Papuans of Humboldt Bay. The hair is crisp, glossy, and extremely elastic, and every hair rolls itself up into a spiral of small diameter.

"In general appearance, thus, it is fine curly like that of Fijians. On comparing it with a very small sample of hair of the natives of Humboldt Bay, taken from several native combs, the Papuan hair proves to be somewhat coarser; but in other respects the two hairs are closely alike, the diameters of the spirals of the curls being the same. Some hair from a native of Api, New Hebrides, is of about the same coarseness as the Admiralty Island hair, but the curls are of much smaller diameter. The hair of the Api Islanders seems to be remarkable for the fineness of its curls. In Tongan hair the curls are of far larger diameter than those of the Papuan or Admiralty Island hair.

"The fineness of the curl of the hair in various Polynesian and Papuan races which I have seen seems to be pretty constant in each race and characteristic. It might be estimated by measuring the diameter of the circles formed by the separate spirally twisted hairs, and taking the average of several measurements. No doubt a certain curve of the hair follicles corresponds with, and produces the curl in the hairs, as in the case of the hair follicles of the negro, as discovered by Mr. Stewart;[2] but the amount of curve will be peculiar to each race. The hair of both head and body of the Admiralty Islanders is naturally black, that of the head being of a glossy black.

"A very slight trace of whiskers is present in most of the men, as a small black streak on the very upper part of the cheek, looking almost like a continuation of the hair of the crown. Regular bushy whiskers were seen only in the case of one man, who had a continuous frill round his face, formed of conjoined whiskers and beard. This man was also remarkable for the greater hairiness of his body; hence I imagine that whiskers and hair generally on the face are exceptional, and not removed by shaving. One or two men had short pointed beards without whiskers.

"Eyebrows were generally absent, very probably shaved off (the natives made signs when offered razors that they used obsidian knives for shaving). I saw eyelashes long and well-developed in some youths.

"The eyes are not in the least oblique, and open full and widely. The iris is of a dark brown. The forehead is somewhat flattened. There is usually a well-marked depression at the origin of the nose, the brow thus somewhat overhanging. The cheek bones are prominent, the face diminishing rapidly beneath them, to terminate in the straight fronted chin. The nose is usually short, with wide alæ and flattened tip. The nostrils are not patent in the adults, or only just to be seen into under the alæ.

"In the children the noses are more flattened, and the nostrils somewhat more patent. The septum

[1] This appearance is probably merely due to the tendency of the hairs evenly distributed at their bases to collect together and combine into curls, and must not be taken to imply necessarily the existence of a condensation or aggregation of hair follicles at certain spots, producing hair growing in separate locks, which condition was formerly erroneously supposed to occur on the scalps of Papuans. The body hairs form small curly locks in other races.

[2] Charles Stewart, M.R.C.S., F.L.S., Note on the Scalp of a Negro, *Micr. Journ.*, 1873, p. 54.

[Dr. T. P. Anderson Stuart confirms the statement of the curve of the hair follicles in the negro, but places the papilla very much laterally to the opening of the follicle, so that the hair grows freely up out of the scalp, and the plane of the curl is vertical to the surface of the scalp. *Journ. Anat. and Phys.*, April 1882.—W. T.]

nasi in all the adults is perforated, and the lower margin of the perforation usually dragged down by the suspension of ornaments, so that in a profile view of the face the large aperture in the septum is looked through by the observer.

"Some of the natives, as at Humboldt Bay, have most remarkable long Jewish noses. About 1 in every 15 or 20 has such a nose. I at first imagined that this form of nose was produced to some extent by long action of excessively-heavy nose ornaments, but I saw one youth of only 16 or 17 with such a nose very fully developed, and I saw more than one woman with a well-marked arched nose with dependent tip, and the women appear to wear no nose ornaments. An incomplete mixture of two races may possibly exist here, but unfortunately I did not carefully observe with this view whether the natives with Jewish noses showed other points in common in which they differed from the remainder of the population. One of the most marked instances of these peculiar features was that of the head man or chief of Wild Island (Oto).

"The lips are of a light brown, very slightly pinkish. They are usually very little prominent, and are not unusually large. The chins are usually straight in front, not rounded, and not prominent, sometimes apparently receding. The jaws are wide. The lower line of the jaws is remarkably straight and horizontal. The lobes of the ears are enlarged and dragged into a long loop by the weight of suspended ornaments. The penis is usually of moderate size. I saw only one man who had a remarkably large one.

"Some few of the women were large and stout. One woman that I saw must have been 5 feet 6 inches in height, but such women were exceptional.

"Drawings of the heads of three natives are given, enlarged from photographs, in Pl. xxiii. figs. 1, 2, 3.

"Variability. The occurrence of Jewish noses in a certain number of the Admiralty Islanders has already been described. As another instance of variability, I may state that I saw one boy on Wild Island who, though in other respects just like the rest, had his hair quite straight. Light-coloured skins were rare, but I saw one man and two women whose skins were of a light yellow colour."

General characters of the crania.—The collection of crania from the Admiralty Islands consisted of eleven skulls, a calvaria, and a face. Only one skull had the lower jaw attached, but there was in addition a loose lower jaw, which could not definitely be associated with any of the crania. The individual crania are distinguished in this description by the letters A to N inclusive.[1]

Several of the crania had the appearance of having been exposed to the weather, as the outer table was peeling off in thin flakes, and the bones were greenish and discoloured. The majority of the crania were smeared with a red pigment, usually without any pattern, but in two specimens A and M, a red band had been drawn around each orbit, and vertical lines on the frontal bone.

The orbits in the skull D were each filled with a black hardened mass, in the centre of which was a valve of a bivalve shell to represent the eye. A similar black material had been used to fill up the hollow at the base of the skull, between the foramen magnum

[1] By the permission of the Lords Commissioners of H.M. Treasury I exhibited and described these crania at the International Medical Congress in London, August, 1881. An abstract of my communication was published in the *Transactions of the Congress*, vol. i. p. 146, Anatomical section, and in the *Journ. Anat. and Phys.*, vol. xvi. p. 135.

and the posterior nares. The nasal fossæ were also occupied by it, and it had been employed to model an artificial nose of a low aquiline form.[1] In seven of the crania a hole had been knocked through the squamous part of each temporal bone, and in two of the specimens a piece of cane had been passed through the holes for the purpose of suspending the skulls. Prof. Moseley states that it is a common practice to stick in the thatch of the houses the skulls of animals and of man. He states that—

"At D'Entrecasteaux Island one having an ornament in the nose was suspended to the front of a house over the doorway, by means of a stick thrust through holes in the two squamous parts of the temporal bone. This skull the owner could not be induced to part with, but usually they were sold pretty freely, and they were in considerable abundance about the houses, but often much shattered. A dozen only were purchased."[2]

In each skull, with one exception, one or both zygomatic arches had been broken, sometimes so much that the greatest zygomatic diameter could not be measured. Two of the crania were tied together by a piece of split cane passed through the sphenomaxillary fissure in the wall of the orbit. The cranial characters were those of persons who had reached adult life, and in two specimens were inclining to a more advanced age. Some of the skulls were undoubtedly males, others females. But it was difficult to decide to which of the two sexes others of the crania had belonged. I have, however, arranged them in two groups, and am disposed to regard seven as males and five as females. The skulls are not large or heavy, and they do not give one the impression of belonging to a people either of big stature or great muscular development, which is in accordance with Prof. Moseley's measurements of height and weight (p. 52).

Norma verticalis.—The crania showed many features in common. They were elongated antero-posteriorly. They were neither flattened nor ridge-shaped at the vertex, but had a gentle curve across the vertex from one parietal eminence to the other. Below the parietal eminences, the sides of the skull approached the vertical, although in the majority of the crania the transverse diameter was a little greater near the squamous suture than at the parietal eminences. In two specimens the stephanic and asterionic diameters were equal, in three the stephanic exceeded the asterionic, in seven the asterionic exceeded the stephanic. Only two specimens were phænozygous, and these but slightly.

Norma lateralis.—Some of the crania rested behind on the conceptacula, others on the mastoid processes and only one on the occipital condyles. With two exceptions the

[1] I may refer to my paper on Two Masks and a Skull from Islands near New Guinea, in *Journ. Anat. and Phys.*, vol. xiv. July 1880, for an account of a number of methods of decorating and preserving the crania or heads of the dead in use amongst the Aborigines of the Malayo-Polynesian Archipelago.

[2] In a recent letter to me Prof. Moseley states:—"from what is now known, it is most probable that the crania obtained from the roofs of the houses were those of persons who were eaten by Admiralty Islanders; their skulls being set up as trophies of the feast, and, according to Miklucho-Maclay, to be used as a kind of chronological record. The skulls collected were probably those of inhabitants of the main island of the Admiralty group caught alive, or bought or killed for food. But if, as is barely possible, the Admiralty Islanders have any intercourse occasionally with neighbouring groups the victims may have come from thence."

glabella and supraciliary ridges were feeble, so much so indeed that the difference between the glabello-occipital and ophryo-occipital diameters in no instance exceeded 2 mm., and usually was not more than 1 mm. The forehead was not retreating. The profile outline of the crania through the upper frontal, parietal, and occipital regions, formed a continuous curve. In all, the most projecting part of the occiput was in the occipital squama above the occipital protuberance. Some of the crania showed a slight flattening in the hinder parietal region; this flattened part was not however vertical, but inclined downwards and backwards to form a curve with the superior occipital squama, so that it did not resemble the flattening produced in the parieto-occipital region in skulls subjected to artificial compression during infancy. In the crania generally the cerebellar fossæ in the occipital bone had no great bulging, and in two specimens this part of the bone was almost flat on its inferior aspect. In K the occipital region was unsymmetrical, for the left side of the bone projected further back than the right. In all except one specimen the frontal longitudinal arc exceeded the occipital. In all except one skull the parietal arc exceeded the frontal, and in all the parietal was greater than the occipital.

The nasal bones were neither large nor very prominent; they varied in length from 15 to 26 mm. and in greatest breadth from 5 to 10 mm. They curved downwards and forwards, so that the osseous bridge of the nose was shallow and concave; but owing to the feeble glabella the naso-frontal suture was not deeply depressed. The interzygomatic exceeded the stephanic, asterionic, and intermalar diameters in all the skulls where the zygomata were so uninjured as to permit that diameter to be measured, but the interzygomatic diameter with one exception (B) was less than the greatest breadth in the parieto-squamous region. In several instances the intermalar breadth was greater than either the stephanic or asterionic. The mean interorbital breadth was 21·7 mm., the maximum in two instances being 26 mm., the minimum in one specimen 18 mm.

In all the specimens except H and K the teeth were fully erupted, but in the majority of the crania the teeth had dropped out of the alveoli, obviously before the skulls were collected. The teeth which remained were either bicuspids or molars, and the grinding surfaces of the crowns were not as a rule much worn down. The incisors were not in place in any one of the skulls, although their sockets were unabsorbed. None of the teeth showed any evidence of decay. G was the only skull in which a canine tooth was present; it was worn almost to a stump, and the sockets of the molars were in process of absorption. In H the sockets of the upper canines and wisdom teeth were absorbed.[1]

The cranial sutures were as a rule simple in their denticulations, and this simplicity

[1] None of the crania exhibited that very remarkable magnitude of the incisor teeth which Miklucho-Maclay has described in some natives of the Admiralty Islands and of Hermit Island. The upper incisors in these persons projected downwards and forwards so as to appear between the lips. In one case, which he measured, the crown of an incisor tooth was 22 mm. long, 19 broad, and 11 mm. thick. The women showed this peculiarity less frequently than the men. See Verhandl. der Berlin Gesellschaft für Anthrop., 16 Dec. 1876, in *Zeitschr. für Ethnol.*, Bd. viii., 1876.

was especially marked in the upper half or so of the coronal suture, and in the more anterior part of the sagittal. In only two specimens, C and G, were the sutures beginning to disappear from senile changes, and in C the molars showed more than in any other skull the effects of use on the crowns. In all, the basi-cranial synchondrosis was ossified. No skull was metopic. In each of the two lower jaws the coronoid process was feeble and the sigmoid notch was shallow. In one the chin was feeble, in the other it was more massive, rounded at its lower border and projected forwards.

In E and I a broad tongue-like process of the squamous temporal was interposed between the left ali-sphenoid and the antero-inferior angle of the parietal. An epipteric bone was situated on the right side of E, between the ali-sphenoid and parietal, and two large epipterics were placed in K between the left ali-sphenoid and parietal. On the right side of D a single epipteric was situated in the spheno-parieto-frontal suture, but it did not entirely cut off the ali-sphenoid from the parietal. H had a similar bone in the spheno-parietal suture. In the other skulls the pterion was normal, though in G the spheno-parietal articulation was very small. One or more Wormian bones were present in the lambdoidal suture in A, B, D, E, F, H, and K; in the last of which they were large and infringed considerably on the area of the parietal bones. In H a small triquetral bone was in the sphenoido-frontal suture.

The male skull K exhibited a rare and interesting irregularity in the ossification of the cranial bones; for in it the right parietal was completely but unequally separated into an upper and a lower division by an antero-posterior suture, situated in the position of the temporal ridge, and extending from the coronal to the lambdoidal suture. This suture was much denticulated, and had an os triquetrum in its posterior third. The vertical diameter of the upper division of this parietal bone, midway between the coronal and the lambdoidal sutures, was 81 millimetres, and of the lower division only 42 mm. A large Wormian bone in the lambdoidal suture infringed upon the posterior part of the upper division. The left temporal ridge of the same skull was well marked, and in proximity both to its anterior and posterior ends was a faint appearance of a suture as if the left parietal also had been separated into an upper and a lower division at an earlier period of life. In the course of my anatomical experience, during which many hundreds of human crania have passed through my hands, I have only seen one other specimen in which a similar division of the parietal bone occurred, and this was in the right parietal of a fœtus, between the eighth and ninth month, dissected by Dr. Ramsay H. Traquair, who described it in the Natural History Review.[1]

Cases of division of the parietal have, however, from time to time been recorded by other anatomists. Winslow[2] and von Doeveren[3] had each in their possession in the last century, and von Sömmerring[4] described in the earlier part of the present century, a

[1] 1863, vol. iii. p. 132.
[2] See Tarin's Osteographie, Paris, 1753.
[3] Specimen Observ. Acad. Groningæ, 1765, quoted by Wenzel Gruber.
[4] Tiedemann and Treviranus's *Zeitschrift für Physiologie*, s. I., Tafel I., 1826.

skull in which one or both parietals had been divided by an antero-posterior suture into an upper and a lower part. In Winslow's and von Sömmerring's cases the crania were adults, in von Doeveren's the skull was that of a child. Wenzel Gruber described[1] the skull of a male fœtus in which, along with other malformations, the left parietal was divided into an upper and a lower portion; also the cranium of an adult in which the posterior and lower part of the left parietal was a separate piece: in 1870 he described and figured[2] a right parietal in a youth as divided into two parts by a suture extending diagonally from the anterior end of the sagittal suture to about the middle of the lambdoidal: in 1876 he described and figured[3] an adult male skull, in which the postero-inferior angle of the parietal, with the part of the bone for some distance above it, was separated from the rest by a suture extending from the squamous to the lambdoidal suture: in 1879 he described[4] three other adult crania; in one the posterior and lower part of the left parietal was separate from the rest of the bone by a suture extending from the squamous to near the apex of the lambdoidal suture, in a second each parietal was divided by a suture extending forwards from the lambdoidal through the lower part of the bone, in the third the right parietal was divided by a suture passing from the lower end of the coronal to about the middle of the lambdoidal suture. Lucæ[5] and Welcker[6] have each described a skull with the parietal divided by an antero-posterior fissure into an upper and a lower part. Hyrtl has also figured[7] the skull of an adult and those of three fœtuses in which a similar division of the bone was met with.[8]

In all the specimens the os planum of the ethmoid was small, and wherever it was uninjured, so that its shape could be determined, it was quadrilateral in form, although in Z its anterior border was elongated forwards and not vertical. In D, F, H, and L, remains of the maxillo-premaxillary suture were visible on the surface of the hard palate. Only in C had the hard palate any great depth, being 16 mm. in that skull opposite the second molar tooth. In five crania a suture extended from the infraorbital foramen through the lower border of the orbit into the floor of the orbit and the infraorbital canal.

In E the nasal bones had apparently not been developed. The nasal spine of the frontal bone appeared on the surface of the osseous bridge of the nose, immediately below the glabella, and descended between the ascending processes of the superior maxillæ. Below the free end of this spine the ascending processes of the superior maxillæ articulated with each other mesially for about $\frac{2}{10}$ths of an inch. In the same skull a distinct

[1] Abhandl. a. d. mensch. u. vergl. Anatomie, 1852; also *Mém. de l'Acad. Imp. de St. Petersbourg*, ser. 7, t. ii., 1859.

[2] *Virchow's Archiv*, Bd. l., p. 113, 1870.

[3] *Virchow's Archiv*, Bd. lxvi., p. 468, 1876.

[4] Beobachtungen aus der menschlichen und vergleichenden Anatomie, Heft ii. p. 12, e.s. pl. iii., Berlin 1879.

[5] Zur Architectur d. Menschenschädels, 1857.

[6] Untersuch. ü. Wachsthum u. Bau des mensch. Schädels, 1862.

[7] Die doppelten Schläfelinien der Menschen-schädel, *Denkschr. d. k. Akad. d. Wiss. Wien.* 1871.

[8] At the meeting of the Anatomical Section of the International Medical Congress, at which I exhibited and described the Admiralty Island crania, I understood Prof. von Kölliker to say that a similar skull was in the Museum of the University of Würzburg.

shallow concave articular facet (third condyle) for the odontoid process of the axis was situated on the anterior border of the foramen magnum.[1] The lateral condyles of the occipital bone did not, however, exhibit a degree of flattening such as is sometimes seen associated with the presence of a third occipital condyle; they were indeed more convex than in others of the crania in which no third condyle was present.

In all the crania the nasal spine of the superior maxillæ was distinctly marked, and the floor of the anterior entrance into the nose formed almost a right angle with the lateral boundary, and was not rounded off, except in L, in which there was marked prognathism of the upper jaw, and the alveoli of the upper incisors projected forward.

The mean cephalic index of twelve crania was 70. That of the seven probable males

TABLE VIII.—ADMIRALTY ISLANDERS, CHAL.

	Collection,	A. Ad.	C. Ad.	D. Ad.	E. Ad.	F. Ad.	K. Ad.	N. Ad.	B. Ad.	G. Ad.	H. Ad.	I. Ad.	L. Ad.	M. Ad.
	Age,	M.	M.	M.?	M.	M.?	M.	M.	F.	F.	F.?	F.	F.	Face.
	Cubic capacity,	1528	1292	1252	1353	1410	1430	...	1068	1257	1220	1187	1130	...
	Glabello-occipital *length*,	185	184	176	186	186	185	184	170	185	178	179	177	...
	Ophryo-occipital ,,	184	183	174	186	185	185	182	169	184	177	180	176	...
	Basi-bregmatic height,	144	131	133	138	138	132	132	124	120	127	130	122	...
	Vertical Index,	77	71	75	74	74	71	72	72	64	71	72	69	...
	Minimum frontal diameter,	90	88	90	97	99	95	100	86	92	86	88	89	91
	Stephanic, ,, ,,	112	105	102	103	110	112	114	100	104	98	94	99	...
	Asterionic, ,, ,,	116	106	98	108	110	112	108	91	118	108	102	102	...
	Greatest parietal breadth,	130*s*	132*s*	129*s*	129*p*	133*s*	130*s*	134*s*	120*s*	125*s*	126*s*	124*p*	121*s*	...
	Cephalic Index,	70	72	73	69	71	70	73	70	67·5	70	69	68	...
	Horizontal circumference,	520	515	490	515	517	517	516	480	510	493	490	485	...
	Frontal longitudinal arc,	140	126	115	136	139	120	127	120	120	117	124	114	116
	Parietal ,, ,,	150	148	137	148	130	150	134	124	133	128	134	130	...
	Occipital ,, ,,	114	...	114	110	127	121	115	110	115	108	118	108	...
	Total ,, ,,	404	...	366	394	396	391	376	354	368	353	376	352	...
	Vertical transverse arc,	320	295	288	301	311	312	...	270	276	283	285	275	...
	Length of foramen magnum,	31	...	28	30	33	33	29	28	33	30	31	34	...
	Basi-nasal length,	100	96	99	95	102	96		96	99	99	100	90	...
	Basi-alveolar length,	98	99	102	102	106	99		92	106	100	98	103	...
	Gnathic Index,	98	103	103	107	103	103		96	107	101	98	114	...
	Interzygomatic breadth,	...	126	127	128	...	...		128	122	...	119	...	...
	Intermalar ,,	112·5	108	109	112	110	116		110	104	108	110	101	113
	Ophryo-alveolar length,	89	84	77	76	75	91		77	88	84	87	80	92
	Naso-alveolar ,,	68	65	62	56	58	72		60	68	66	64	61	70
	Facial Index,	...	66	61	59	...	...		60	73	...	73	...	...
	Nasal height,	51	48	...	45	46	54		51	56	57	47	49	52
	Nasal width,	24	26	...	25	25	22		22	25	22	21	25	28
	Nasal Index,	47	54	...	55	54	41		41	44	38	45	51	54
	Orbital width,	38	37	39	37	37	39		35	37	38	39	33	39
	Orbital height,	36	29	33	31	30	38		28	32	30	34	32	32
	Orbital Index,	95	78	84	83	81	97		80	86	79	87	97	82
	Palato-maxillary length,	58	59	54	57	56	55		51	58	51	54	59	...
	Palato-maxillary breadth,	60	62	64	63	61	65		59	62	62	56	63	...
	Palato-maxillary Index,	113	105	118	110	109	118		115	107	121	104	107	...
Lower Jaw.	Symphysial height,	...	...	...	...	...	...		...	...	27	...	...	29
	Coronoid ,,	...	...	...	...	..	...		...	...	62	...	...	50
	Condyloid ,,	...	...	...	...	...	...		...	...	64	...	...	54
	Gonio-symphysial length,	...	...	...	...	...	...		...	...	93	...	...	86
	Inter-gonial width,	...	...	...	...	...	...		...	...	80	...	...	79
	Breadth of ascending ramus,	...	...	...	...	...	...		...	...	...	...	...	...

Calvaria only.

[1] The changes which lead to the formation of a third condyle in this region have been discussed by the late Prof. Halbertsma, De derde Gewrichtsknobbel, 1865, abstracted by Dr. Barnard Davis in an article on Dutch Anthropology in the *Anthropological Review*, vol. iii. 1865, and by Dr. Wm. Allen in *Journ. Anat. and Phys.*, vol. xv. p. 60, 1881.

was 71; of the five probable females 69. The maximum cephalic index in two of the crania (males) was 73; the minimum in one (female) 67·5. The skulls were therefore markedly dolichocephalic, for not a single specimen had a mesaticephalic, and still less a brachycephalic index.

The mean vertical index of twelve crania was 72; that of the males was 73, of the females 70. The mean of the whole series and of the males was metriocephalic, that of the females tapeinocephalic. The maximum vertical index in one (male) was 77, the minimum in one (female) was 64. The mean height in relation to the length was somewhat greater than the mean breadth; a result which was due to the greater vertical diameter of the male crania. For the mean basi-bregmatic height of seven males was 135 mm.; the maximum being 144, the minimum 131 mm. The mean corresponding height of five females was only 125 mm.; the maximum being 130, the minimum 125 mm. In the males the height exceeded the greatest breadth in five cases, but in two the breadth very slightly exceeded the height. In the females the height was slightly in excess of the breadth in four cases, whilst the breadth somewhat exceeded the height in one.

Owing to the broken zygomatic processes in several of the crania, the bizygomatic diameter could only be taken in six specimens, and consequently in these only could the proportion of the breadth to the ophryo-alveolar length be measured, and a facial index be obtained. The mean facial index was 65; that of three males 62, and three females 68. The maximum facial index in one (female) was 73, the maximum in one (male) 59.

The mean gnathic index of eleven crania was 103, and this general average was alike in the two sexes. The maximum gnathic index in one skull (female) was 114; the minimum in one (female) 96. If we take 103 as marking the lowest term of prognathism, then four of the crania reached this index, and only three exceeded it; whilst three skulls ranged from 98 to 101, and one was below 98. Hence it may be said that one was orthognathous, three were mesognathous, four were at the lowest term of prognathism, and only three were decidedly prognathic. The mean average of the series was on the line between mesognathism and prognathism. The basi-nasal length was greater than the basi-alveolar in three crania, *i.e.*, in those in which the gnathic index was below 100.

The mean nasal index of eleven crania was 48; that of six males was 51, that of five females was 44. The maximum nasal index in one skull (male) was 55; the minimum in one skull (female) was 38. Four of the skulls, and these all males, were platyrhine, one, a female, was mesorhine, and the remaining six were leptorhine. The mean average was on the line between the leptorhine and mesorhine.

The mean orbital index of twelve crania was 86; and this index was alike in the two sexes. The maximum orbital index was 97 in both a male and a female, the minimum was 78 (male). Both in the males and females the mean orbital index was mesoseme, although in two males and one female it rose to megaseme, and in four males and two females it sunk to microseme.

The mean palato-maxillary index of eleven crania was 112, and this index was practically the same in the two sexes. The maximum palato-maxillary index was 121 (female), the minimum was 104, also a female. The palate exhibited, therefore, as a rule, no great disproportion between its breadth and its length, it was mesuranic, and like the crania of the Fiji Islanders measured by Prof. Flower, was in its form rather intermediate between the parabolic and the hypsiloid.

As seven of the crania had holes in the squamous temporals, and one other was slightly imperfect near the foramen magnum, the cubic capacities could only be estimated approximately. The mean capacity of eleven crania was 1285 cubic centimetres.[1] That of six males was 1377·5, that of five females was 1154. The maximum cranial capacity in one (male) was 1528; the minimum in one (female) was 1068. Only one skull classified as female exceeded in capacity the lowest of the skulls classified as males. This classification was based upon the general characters of the skulls, and not upon their capacities. If we take 1350 cubic centimetres as the lowest limit of mesocephalism, then four of the eleven skulls exceeded it, and these were probably male skulls. Of these four, one was megacephalic, and three were mesocephalic. The two remaining male skulls were microcephalic. The male crania, therefore, may be regarded as in the average mesocephalic in capacity, the female as microcephalic; and the general average capacity of the series was microcephalic. The ratio between the sexes is as 100 to 84, which is a low average for the female.[2]

To summarise the conclusions now arrived at from the analysis of the table of measurements, I may state that the crania of the Admiralty Islanders are distinctly dolichocephalic; on the line between tapeinocephalic and metriocephalic; cryptozygous; on the line between mesognathism and prognathism; on the line between the leptor-

[1] These figures of the cubic capacity differ somewhat from those printed in the abstract in the *Trans. Inter. Med. Congr.*, for the measurements I had made at that time were with sand, whereas those now given have been taken with shot in the manner described in the introduction to this Report.

[2] In the collection was another skull, marked in Prof. Moseley's handwriting, "Admiralty Islander?" In a letter to me, Mr. Moseley states that he found the skull unlabelled in one of the cupboards of the laboratory on the Challenger, but could get no one to identify it with certainty. From various circumstances he was disposed to think that it came from the Admiralty Islands, and wrote therefore upon it, but with a query. Owing to the uncertainty as to where it came from, and from the differences between it and the skulls which undoubtedly came from one of those islands, I have not included it in the description. The length of the cranium was 178 mm., its greatest breadth was 142 mm.; its basi-bregmatic height 135 mm. It was not only absolutely shorter than the greater number of the Admiralty Island skulls described above, but it was very much wider than even the widest of them, so that its cephalic index was 80. Its vertical index was 76, which places it considerably above the mean of the other crania. The gnathic index was 100; the palato-maxillary index was 126, the palate being distinguished by its great width in relation to its length. This skull had a very different appearance from those above described. Its great width gave it the rounded brachycephalic form. Its interzygomatic breadth was 140 mm., which gave a breadth to the face much in excess of the widest face amongst the above crania. No pigment had been smeared over the bones. If they were natives of the Admiralty Islands I have no hesitation in saying that this skull did not belong to the same race, so that if it were collected on Wild Island, it was a representative of a different people from those whose crania are described in the text. As they were the rule and it the exception, it was, granting the accuracy of its place of collection, probably an imported specimen, not unlikely a brachycephalic brown Polynesian.

hine and mesorhine as regards the nasal index; mesoseme as regards the orbital index, mesuranic as to the length and breadth of the palato-maxillary arch; microcephalic for the females, but mesocephalic for the males.

SANDWICH ISLANDERS.

Plates V., VI. Tables IX., X., XI., XII., XVIII., XIX.

These crania were from two different islands in the group, viz., Hawaii and Oahu. Four skulls were presented by W. L. Green, Esq., the foreign minister to the King of the Sandwich Islands, who took them from a cave on Waimea Plains, Hawaii, near the Hill of Holohaloku. Mr. Green, in a letter to Sir Wyville Thomson, states that "this cave is an ancient burial place, and that it contains the remains of dozens of skeletons. Some of the bodies are mummified, and implements are also found. Some years ago a drunken white set fire to the place, and there are bushels of charred bones there. Some of these skulls sent shew marks of the fire. I have sent some eighty skulls to Dr. J. Barnard Davis, who has them all gauged and catalogued."

The other crania, thirty-three in number, some of which were accompanied by other bones of the skeleton, were contained in boxes labelled "Kanakas from Oahu, Sandwich Islands, 15 miles from Honolulu." These skulls are referred to by Prof. H. N. Moseley, in his Notes by a Naturalist on the Challenger,[1] in the following paragraphs:—

"Whilst the ship was at Honolulu, I visited the north-east side of the island and collected at Waimanalo, on the estate of Mr. John Cumming, a series of native skulls from a deserted burial-place. The burials are amongst dunes of calcareous sand, and the bones are exposed by the shifting of the sands by the wind. The burials are often on the sides of the gullies between the dunes. They have probably been made in this locality because of the ease with which the sand is excavated. Similar burials occur at various spots around the coast of Oahu, and I know of no place where so abundant material is ready at hand for the study of the skeletal peculiarities of a savage race, by the examination of long series of crania and skeletons, as here. Other burials occur in caves inland, where the bodies are found in a dried mummy-like condition.

"All the bodies at Waimanalo were buried in a doubled-up posture. One which was exhumed with care *in situ*, was buried with the knees bent up to the chest and the head bent forwards, and was placed resting horizontally on the back. Chips and fragments of basalt were found around all the graves, but no implements of stone."

Hawaii.—As the four crania from Waimea, Hawaii, possessed a strong family resemblance to each other, I shall in the first instance describe their characters. They were all adults, and apparently males.

Norma verticalis.—Broad-headed, parietal tubera prominent. They were scarcely ridged in the sagittal region; the sides of the cranium were almost vertical below the

[1] London, 1879.

tubera. They were slightly phænozygous. The stephanic diameter was in all in excess of the asterionic, and the greatest breadth was in two cases in the parietal, in the others in the squamous regions.

Norma lateralis.—The skulls rested behind on the mastoids or on the occipital condyles. The glabella and supraciliary ridges were not especially prominent, except in one specimen; the frontal profile did not recede greatly from the glabella. The skulls were somewhat flattened behind, in the region of the obelion and occipital squama, and there was a rapid downward slope from the obelion to the inion, and with a comparatively slight projection of the occipital squama behind the inion, characters which are so marked in brachycephalic skulls. It is possible that the flattening had been assisted by artificial pressure applied during infancy. In three of the specimens there was a slight obliquity in the occipital region, as if the pressure had not been symmetrical. The frontal longitudinal arc was always in excess of the parietal, and the parietal, except in one specimen, was in excess of the occipital. The cerebellar part of the occipital bone was not horizontal, but sloped upwards and backwards to the protuberance and superior curved line; the conceptacula cerebelli had no especial bulging. The foramen magnum was always longer than wide: the maximum length was 35 mm., and the width in the same skull was 29 mm.

The bridge of the nose was slightly concavo-convex and not very prominent. The nasal bones varied in length from 22 to 25 mm. and in width from 8 to 12 mm. The nasal spine of the superior maxillæ was distinct but not strong. The junction of the side wall with the floor of the anterior nares was slightly rounded. In the skull with strong supraciliary ridges the external angular processes were prominent, and the temporal ridges were strong. The interzygomatic breadth considerably exceeded the intermalar, stephanic, and asterionic, and the intermalar breadth in each case was somewhat greater than the stephanic and considerably more than the asterionic; but the interzygomatic was less than the greatest transverse diameter. The mean interorbital breadth was 25·5, the maximum 28, the minimum 23. In A the length of the face was from the ophryon to the chin 135 mm., from the fronto-nasal suture to the chin 112 mm. In B the corresponding dimensions were respectively 126 and 108 mm.

The teeth in all were fully erupted, except in one, in which the wisdoms were not present; the teeth were not much worn, and there was no decay. The sutures were sometimes simple, at others more denticulated and not obliterated from age. No Wormian bones were in the lambdoidal suture. One skull had a triquetral bone in the left pterion and two in the right. In A the squamous temporal articulated with the frontal in the right pterion. The os planum was normal except on the left side of B, in which a small triquetral intervened between its upper half and the lachrymal. No skull was metopic, and there was no division of the malar bone. In one the maxillo-premaxillary suture was faintly indicated on the palate. In C an elongated ivory exostosis projected from the posterior wall of each auditory meatus outwards to the orifice. In D a large

paramastoid depended from the right jugal process of the occipital. In A a small third condylar surface was at the front of the foramen magnum, but without marked flattening of the occipital condyles. Both in A and D a suture extended through the infraorbital foramen into the floor of the orbit.

A and B had lower jaws, not very massive and with no great development of chin.

TABLE IX.—WAIMEA PLAINS, HAWAII, SANDWICH ISLANDS, CHAL.

Brachycephali.

		A.	B.	C.	D.
	Collection,	A.	B.	C.	D.
	Age,	Ad.	23	Ad.	Ad.
	Sex,	M.	M.	M.	M.
	Cubic capacity,	1338	1635	1420	1328
	Glabello-occipital length,	169	178	176	173
	Ophryo-occipital „	167	174	172	170
	Basi-bregmatic height,	142	143	142	138
	Vertical Index,	*84*	*80*	*81*	*80*
	Minimum frontal diameter,	90	102	98	95
	Stephanic, „ „	112	118	123	110
	Asterionic, „ „	101	113	108	104
	Greatest breadth,	142*p*	148*s*	146*s*	148*p*
	Cephalic Index,	*84*	*83*	*83*	*85*
	Horizontal circumference,	492	523	510	510
	Frontal longitudinal arc,	122	131	132	126
	Parietal „ „	119	130	122	118
	Occipital „ „	109	119	106	121
	Total „ „	350	380	360	365
	Vertical transverse arc,	310	323	325	312
	Length of foramen magnum,	30	35	33	31
	Basi-nasal length,	107	102	108	102
	Basi-alveolar length,	106	100	100	96
	Gnathic Index,	*99*	*99*	*92*	*94*
	Interzygomatic breadth,	136	144	143	130
	Intermalar „	122	122	125	120
	Ophryo-alveolar length,	85	85	92	90
	Naso-alveolar „	64	64	71	64
	Facial Index,	*62*	*59*	*64*	*69*
	Nasal height,	48	50	56	51
	Nasal width,	23	26	26	21
	Nasal Index,	*48*	*52*	*46*	*41*
	Orbital width,	37	38	36	36
	Orbital height,	34	37	36	36
	Orbital Index,	*92*	*97*	*100*	*100*
	Palato-maxillary length,	57	54	56	54
	Palato-maxillary breadth,	62	64	67	63
	Palato-maxillary Index,	*109*	*118*	*119*	*116*
Lower Jaw.	Symphysial height,	30	24	...	...
	Coronoid „	69	67	...	...
	Condyloid „	71	57	...	...
	Gonio-symphysial length,	91	93	...	...
	Intergonial width,	95	104	...	...
	Breadth of ascending ramus,	39	41	...	...

The sigmoid notch in A was very shallow, in B a little deeper. The gonio-symphysial length in both was less than the intergonial width.

The mean cephalic index was 84, and the range of variation from 83 to 85 was only 2. The skulls were therefore all decidedly brachycephalic. The mean vertical index was 81, and the range of variation from 80 to 84, was only 4. The mean basi-bregmatic height was below the mean breadth, and in only one specimen were these dimensions equal. The skulls were decidedly akrocephalic. The mean gnathic index was 96, and the range from 92 to 99 was 7. Two were orthognathic and two mesognathic. The mean facial index was 74·5 and the range from 71 to 77 was 6. The mean nasal index was 47, and the range from 41 to 52 was 11. Two were mesorhine, two leptorhine. The mean orbital index was 97, and the range from 92 to 100 was 8. They were all megaseme. The mean palato-maxillary index was 115, and the range from 109 to 119 was 10. The average cubic capacity was 1430 c.c.; the maximum 1635 c.c., the minimum 1328 c.c.; the skulls therefore were in the mean mesocephalic.

These skulls from Waimea were in their average proportions brachycephalic, akrocephalic, phænozygous, either orthognathic or mesognathic, leptorhine or mesorhine, megaseme, on the verge of brachyuranic and mesocephalic.

Oahu.—The skulls and accompanying bones of the skeleton from Oahu were with few exceptions bleached perfectly white from exposure, those not white were light brown, and had without doubt been concealed in the sand.

Two distinct types of skulls were found in the series; the one definitely brachycephalic, the other as distinctly dolichocephalic, whilst a third set were intermediate in the form and proportions of the cranium.

The brachycephalic crania were seven in number, and are distinguished in the accompanying table by the letters I, K, S, V, Aa., Ac., Ah. They were all adults, with the exception of Ah. Judging from the dentition, Ah. was a child of 8 or 9, probably a boy; the milk molars and the first true molar were in place, but the second true molar and canines had not erupted. Four of the adults were evidently males, two females, and one of the latter was accompanied by the pelvis and other bones of the skeleton. I compared these adult skulls with the series of four brachycephali from a cave on Waimea Plains above described, and I found that the general configuration of the cranium was so much alike in both series, that no special description of these specimens from Oahu seems to be necessary, though it should be stated that the skulls from Oahu were cryptozygous. In each skull the frontal arc and the parietal arc exceeded the occipital. In four skulls the frontal and parietal arcs were almost or quite equal to each other; in two the frontal arc considerably exceeded the parietal; in one the parietal exceeded the frontal. In each skull the stephanic diameter was greater than the asterionic. In the males the greatest parietal diameter was nearer the parietal eminence than the

squamous suture, in the females and child the reverse was the case. The interzygomatic diameter was considerably below the interparietal. The mean interorbital diameter was 23·5, the maximum 26, the minimum 21. The bridge of the nose was slightly concavo-convex, the nasal bones varied in length from 21 to 25, and in greatest breadth from

TABLE X.—OAHU, SANDWICH ISLANDS, CHAL.

Brachycephali.

		K.	S.	V.	Aa.	I*.	Ac.	Ah.
	Collection,	K.	S.	V.	Aa.	I*.	Ac.	Ah.
	Age,	Ad.	Ad.	Ad.	21	Ad.	Ad.	Æt. 8
	Sex,	M.	M.	M.	M.	F.	F.	M?
	Cubic capacity,	1398	1675	1535	1430	1345	1495	1508
	Glabello-occipital length,	176	184	182	174	175	178	164
	Ophryo-occipital „	174	180	179	174	174	176	165
	Basi-bregmatic height,	140	144	142	141	136	140	132
	Vertical Index,	*79*	*78*	*78*	*81*	*78*	*78*	*80*
	Minimum frontal diameter,	96	98	97	92	94	88	92
	Stephanic, „ „	121	126	115	112	112	115	117
	Asterionic, „ „	102	116	110	105	105	102	114
	Greatest breadth,	146*p*	155*p*	148*p*	150*p*	146*s*	146*s*	152*s*
	Cephalic Index,	*83*	*84*	*81*	*86*	*83*	*82*	*92*
	Horizontal circumference,	506	541	523	504	512	506	499
	Frontal longitudinal arc,	126	140	128	128	125	127	124
	Parietal „ „	136	107	124	128	125	126	117
	Occipital „ „	112	...	118	105	120	118	109
	Total „ „	374	...	370	361	370	371	350
	Vertical transverse arc,	313	338	325	333	310	318	328
	Length of foramen magnum,	29	...	36	35	32	32	34
	Basi-nasal length,	100	108	110	...	100	104	89
	Basi-alveolar length,	97	...	110	...	102	104	88
	Gnathic Index,	*97*	...	*100*	...	*102*	*100*	*99*
	Interzygomatic breadth,	129	142	138	...	126	129	119
	Intermalar „	115	124	119	...	110	110	108
	Ophryo-alveolar length,	88	...	89	...	85	86	73
	Naso-alveolar „	69	...	66	...	63	63	57
	Facial Index,	*68*	...	*64*	...	*67*	*67*	*61*
	Nasal height,	48	...	51	...	47	50	42
	Nasal width,	22	...	23	...	27	24	20
	Nasal Index,	*46*	...	*45*	...	*57*	*48*	*47*
	Orbital width,	37	38	39	...	36	36	34
	Orbital height,	35	35	31	...	33	37	33
	Orbital Index,	*95*	*92*	*79·5*	...	*92*	*103*	*97*
	Palato-maxillary length,	53	...	58	...	55	54	45
	Palato-maxillary breadth,	...	...	65	...	66	...	59
	Palato-maxillary Index,	...	...	*112*	...	*124*	...	*131*
Lower Jaw.	Symphysial height,	26	...	...	...	28	...	...
	Coronoid „	64	...	...	...	60	...	...
	Condyloid „	62	...	...	...	53	...	...
	Gonio-symphysial length,	86	...	...	...	88	...	...
	Intergonial width,	89	...	...	...	86	...	...
	Breadth of ascending ramus,	33	...	...	...	35	...	...

* With pelvis.

6 to 10 mm. S and V had each a small exostosis in the roof of the right auditory meatus. Ah. had a triquetral bone in each pterion and V one in the left pterion. On the right side of I was a large spheno-pterygoid foramen, due to the development of a plate of bone between the external pterygoid process and the spine of the sphenoid; on the left side the foramen was not quite complete. No skull was metopic. In K, V, and Ac., a suture extended from the infraorbital foramen into the floor of the orbit and infraorbital canal.

In the two lower jaws the sigmoid notch was shallow, and the coronoid process was on the whole feeble. The chin was fairly marked. The gonio-symphysial and intergonial diameters were nearly equal. The child's skull being excluded, the mean cephalic index was 83. The adults ranged in the cephalic index from 81 to 86, but the child had an index of 92. The mean vertical index was 79, which places them in the akrocephalic series, though not so high as the Waimea skulls. The somewhat smaller average of the vertical index was probably due to two of the adult crania from Oahu being females. The mean gnathic index was 100, somewhat higher, therefore, than those from Waimea, so that they were with one exception mesognathous. Owing to the nasal index of the female skull I being as high as 57, the mean was raised to 49, so that the average was mesorhine. The mean orbital index of the adults was 92, and they were all megaseme except V, which was microseme. In only two of the adults could the palate be measured, and the mean palato-maxillary index of these specimens was 118. The mean cubic capacity of the set of seven skulls was 1484 c.c.; that of four adult males was 1509·5 c.c., of two adult females 1420 c.c.; the males were megacephalic, the females mesocephalic. This group of Sandwich Islanders was in their mean proportions brachycephalic, akrocephalic, cryptozygous, mesognathic, mesorhine, megaseme, brachyuranic, and mesocephalic.

Fifteen of the crania from Oahu had the cephalic index below 75 and were all distinctly dolichocephalic. They were all adults. Eight were presumably males and seven females, and of the latter three were accompanied by the pelvis and other bones of the skeleton.

Norma verticalis.—Sagittal line was ridged, the parietal eminences were prominent, and the roof of the skull had a ridge-shaped and "ill filled" appearance. The cranium was both more elongated and narrower than in the brachycephali. The greatest parietal breadth, both in the males and females, was sometimes near the parietal eminence, at others near the squamous suture. As distinguished from the brachycephalic skulls, in only one instance did the greatest parietal diameter exceed 140 mm., viz., in Y, in which it was 142 mm., whilst in the two groups of brachycephali in only one instance was it as small as 142 mm., and in three specimens it reached 150 mm. or upwards. On the other hand, in the dolichocephali the glabello-occipital diameter fell in only one instance below 180 mm. (viz. in A to 175 mm.), whilst in three specimens it exceeded 190 mm. In

the brachycephali the corresponding diameter was in one case as low as 164 mm., and it exceeded in only two cases 180 mm. The stephanic diameter was usually greater than the asterionic, although sometimes the asterionic was wider in the same skull; but the average stephanic was markedly less than in the brachycephali. Below the parietal eminences the skulls were wall-sided. With three exceptions they were phænozygous.

Norma lateralis.—These skulls showed a continuous gentle curve from the glabella to the inion, and had not an abrupt descent from the obelion to the inion which characterised the brachycephalic crania above described. There was no definite sign of flattening from artificial pressure. The glabella and supraciliary ridges were not particularly prominent, even in the male skulls, and the frontal profile receded in them from the glabella. The cerebellar region of the occiput, although not horizontal, yet did not slope so much upwards to the inion as in the brachycephali. Many of the crania when placed on a plane surface rested behind on the conceptacula cerebelli, but some rested on the occipital condyles. The frontal longitudinal arc exceeded in eight specimens the parietal, but in six specimens was below it. The parietal arc was in excess of the occipital in all except three specimens.

The osseous bridge of the nose was concave or concavo-convex, and sometimes so curved that the nostrils would doubtless have been directed downwards and forwards. The nasal bones varied in length from 20 to 25 mm., and in greatest breadth from 5 to 13 mm. The nasal spine of the superior maxillæ was not strongly marked. The sides of the nasal opening were rounded at their junction with the floor of the nose. The interzygomatic and intermalar diameters were greater than either the stephanic or asterionic. The interzygomatic diameter approached more closely the greatest breadth in the parieto-squamous region than in the brachycephali from the same locality, and in three instances somewhat exceeded it. The mean interorbital width was 24 mm.; the maximum 28 mm., the minimum 20 mm. In some of the skulls the teeth had been lost, and some others were much worn, but there was no decay. In several of the crania obliteration of the sutures from age was in progress. In four specimens Wormian bones were in the lambdoidal suture. The os planum of the ethmoid was normal. No skull was metopic, and there was no subdivision of the malar bone. Faint indications were seen on the hard palate of the maxillo-premaxillary suture in two specimens. In one skull a deep-seated exostosis projected from the anterior wall of the external meatus. In B a spheno-pterygoid foramen was present on each side, and in W a projection from the sphenoidal spine approached the external pterygoid plate of the sphenoid. D had a paramastoid process on the left side. In several of these crania a suture extended from the infraorbital foramen into the floor of the orbit and infraorbital canal.

In the lower jaws the sigmoid notches had no great depth; the chin was not massive. The intergonial width was in three cases equal to the gonio-symphysial length, though in two it surpassed and in two was somewhat less than the latter.

In this series of skulls the mean cephalic index for each sex was 73, the minimum both a male and a female 71, and the maximum both males and females 74. They are therefore distinctly dolichocephalic. The mean vertical index was 75, which is considerably below that of both the groups of brachycephali in Tables IX. and X., and exists both in the male and female series. They are therefore metriocephalic. The mean basi-bregmatic height of the seven female skulls was 136 mm.; the maximum height was 140 mm., and the minimum was 132 mm. The mean corresponding height of six male skulls was 143 mm.; the maximum was 150 mm., and the minimum was 138. These measurements are confirmatory of the observations made by Ecker, Cleland, and

TABLE XI.—OAHU, SANDWICH ISLANDS, CHAL.

Dolichocephali.

		C.	D.	G.	Q.	R.	U.	Y.	Ad.	A.*	B.*	L.*	W.	X.	Ae.	Ag.
	Collection,	Aged.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Aged.	Aged.	Ad.
	Age,	M.	M.	M.	M.?	M.	M.?	M.	M.	F.	F.	F.	F.	F.	F.	F.
	Sex,	...	1465	1345	...	1332	1488	...	...	1218	1470	1362	1280	1425	1227	1358
	Cubic capacity,	188	184	186	184	184	194	192	188	175	193	186	182	186	180	180
	Glabello-occipital length,	187	182	180	182	181	192	189	185	175	193	182	180	182	178	179
	Ophryo-occipital ,,	150	146	144	...	142	140	...	138	136	138	136	135	140	132	133
	Basi-bregmatic height,	*80*	*73*	77	...	*77*	*72*	...	*73*	27	*71*	*73*	*74*	*74*	*73*	*74*
	Vertical Index,	100	94	102	87	90	99	99	96	90	98	96	93	95	88	92
	Minimum frontal diameter,	108	104	110	108	108	114	116	118	102	109	110	112	112	95	110
	Stephanic, ,, ,,	110	104	109	104	108	108	110	100	100	97	106	104	108	108	104
	Asterionic, ,, ,,	138*p*	134*p*	138*s*	136*p*	132*s*	138*p*	142*s*	138*s*	128*p*	138*p*	138*s*	136*s*	137*p*	130*p*	134*s*
	Greatest breadth,	*73*	*73*	*74*	*74*	*72*	*71*	*73*	*73*	*73*	*71*	*74*	*74*	*74*	*72*	*74*
	Cephalic Index,	538	510	515	502	508	541	538	524	485	530	522	511	515	494	508
	Horizontal circumference,	134	123	123	131	135	128	127	130	127	136	124	128	130	120	114
	Frontal longitudinal arc,	130	...	123	124	127	127	142	129	132	131	135	127	119	128	120
	Parietal, ,, ,,	116	...	112	118	119	136	...	...	104	118	118	113	133	122	130
	Occipital, ,, ,,	380	375	358	373	381	391	...	...	363	385	375	368	373	370	364
	Total ,, ,,	310	314	298	293	307	312	315	311	300	310	302	298	308	295	302
	Vertical transverse arc,	34	36	31	...	35	33	...	...	33	35	34	33	37	30	36
	Length of foramen magnum,	118	107	116	...	104	109	...	108	96	108	104	102	108	104	99
	Basi-nasal length,	110	110	116	...	...	104	...	109	92	108	108	101	97	108	100
	Basi-alveolar length,	*93*	*103*	*100*	...	...	*95*	...	*101*	*96*	*100*	*104*	*99*	*90*	*104*	*101*
	Gnathic Index,	132	141	142	126	134	137	136	...	118	...	135	132	137	126	...
	Interzygomatic breadth,	116	121	124	112	116	120	124	120	108	115	119	116	116	114	115
	Intermalar ,,	87	84	85	82	...	84	91	91	78	89	88	63	88	90	87
	Ophryo-alveolar length,	65	63	63	61	...	64	66	70	55	63	63	65	65	68	65
	Naso-alveolar ,,	*66*	*59*	*60*	*63*	...	*61*	*67*	...	*66*	...	*65*	*62*	*64*	*71*	...
	Facial Index,	56	60	53	50	53	48	51	52	41	51	49	51	52	50	51
	Nasal height,	26	27	27	23	...	26	27	24	23	27	27	26	26	24	25
	Nasal width,	*46*	*45*	*51*	*46*	...	*54*	*53*	*46*	*56*	*53*	*55*	*51*	*50*	*48*	*49*
	Nasal Index,	40	40	37	35	36	38	39	39	35	39	38	36	39	37	38
	Orbital width,	36	34	34	31	30	30	35	36	31	34	32	31	34	32	36
	Orbital height,	*90*	*85*	*92*	*89*	*83*	79	*90*	*92*	*89*	*87*	*84*	*86*	*87*	*86*	*95*
	Orbital Index,	54	59	58	54	...	58	56	57	53	56	56	51	48	56	51
	Palato-maxillary length,	61	59	63	63	...	65	61	59	53	64	65	58	61	60	62
	Palato-maxillary breadth,	*113*	*100*	*109*	*117*	...	*112*	*109*	*103*	*100*	*114*	*116*	*114*	*127*	*107*	*121*
	Palato-maxillary Index,	24	28	33	...	25	...	...	...	25	31	30	...	...	...	...
Lower Jaw.	Symphysial height,	64	65	72	...	62	...	...	...	60	67	67	...	...	...	...
	Coronoid ,,	...	63	68	...	60	...	...	...	55	62	62	...	...	...	...
	Condyloid ,,	84	86	98	...	84	...	...	...	86	92	95	...	...	...	...
	Gonio-symphysial length,	88	93	98	...	84	...	...	...	86	88	93	...	...	...	...
	Intergonial width,	36	38	43	...	36	...	...	...	36	43	43	...	...	...	...
	Breadth of ascending ramus,															

* With Pelvis.

other craniologists, that the female skull has a less vertical diameter than the male. In the male crania the height and breadth in one skull were equal, in all the others the height of each skull exceeded its breadth by from 2 to 12 mm. In the female crania six were either equal or almost equal in height and breadth, and in only one specimen did the height surpass the breadth by 8 mm. The mean gnathic index was 98·6, *i.e.*, mesognathous; four of the skulls were orthognathous, six mesognathous, and two, both of which were females, decidedly prognathous. The mean nasal index was 50, *i.e.*, mesorhine, but four specimens were leptorhine, and three were platyrhine. The mean orbital index was 87·6, *i.e.*, mesoseme; only two specimens were microseme, whilst five were megaseme. The mean palato-maxillary index was 111, and it is remarkable that in two of the specimens the length and breadth were equal, whilst in a third the breadth exceeded the length by only 2 mm. The mean capacity was 1361 c.c.; that of four males 1407·5 c.c.; that of seven females 1334 c.c. The general average, as well as that of the males, was mesocephalic, the females microcephalic. The average is much below that of the brachycephali measured in Tables IX. and X., which though in part, perhaps, to be accounted for by the smaller proportion of male skulls, is presumably also in part due to racial differences.

This group of Sandwich Islanders was, in its average proportions, dolichocephalic, metriocephalic, as a rule phænozygous, mesognathic, mesorhine, mesoseme, mesuranic, and mesocephalic.

From the great differences in the absolute and relative length and breadth of these dolichocephalic crania as compared with the brachycephalic skulls described on p. 65, as well as from the difference in their vertical index, I can have no doubt that the dolichocephalic skulls belonged to a different race from those that had the brachycephalic form and proportions.

Eleven skulls from Oahu ranged in their cephalic index from 75 to 79 inclusive, and were mesaticephalic, therefore, in their proportions. They were all adults; six were presumably males and five females. Although I have grouped them in a table separate from the purely brachycephalic and dolichocephalic skulls from the same locality, I do not wish it to be supposed that I regard them as belonging to a distinct race. The line, indeed, which separates mesaticephalic skulls, on the one hand from dolichocephali, and on the other from brachycephali, is quite arbitrary, so that crania with mesaticephalic proportions pass almost insensibly either into brachycephalic or dolichocephalic according to their place either at the upper or lower term of the series. Such skulls as E, F, N, and T (Table XII.), had a cephalic index so little above 74·9, which it is customary to assume to be the highest term of the dolichocephalic series, and were so closely allied in shape to the dolichocephalic skulls (Table XI.), that there can, I think, be no doubt they were of the same race. If they had therefore been included with them in Table XI., they would have slightly raised the cephalic index of the dolichocephalic series.

On the other hand, O, P, and M, with a cephalic index of either 78 or 79, not only approached in dimensions the lowest term of the brachycephalic series, but corresponded with those skulls in the form of the parieto-occipital region, and ought perhaps to have been associated with that series (Table X.) The four skulls which have a cephalic index

TABLE XII.—OAHU, SANDWICH ISLANDS.

Mesaticephali.

		E.	H.	N.	O.	P.	T.	F.	M.	Z.	Ab.	Af.
	Collection,	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Aged.	Ad.	Ad.	Ad.	Ad.
	Age,	M.	M.	M.	M.	M.	M.?	F.	F.	F.	F.	F.
	Sex,	1418	1478	1364	1330	1476	1495	1412	1226	...	...	1450
	Cubic capacity,	181	179	188	180	182	189	182	172	182	183	186
	Glabello-occipital length,	179	175	184	176	179	186	181	172	182	181	185
	Ophryo-occipital „	142	138	134	140	135	139	137	132	128	...	130
	Basi-bregmatic height,	*78*	*77*	*71*	*78*	*74*	*73*	*75*	*77*	*70*	...	*70*
	Verticat Index,	98	90	94	90	95	92	96	91	95	93	87
	Minimum frontal diameter,	114	106	108	109	116	114	109	107	112	116	106
	Stephanic, „ „	104	104	109	107	115	108	108	102	109	108	107
	Asterionic, „ „	138*p*	138*s*	142*p*	142*s*	144*s*	142*p*	137*s*	134*p*	141*s*	141*p*	143*p*
	Greatest breadth,	*76*	*77*	*75*	*79*	*79*	*75*	*75*	*78*	*77*	*77*	*77*
	Cephalic Index,	507	509	522	512	528	530	521	490	520	514	520
	Horizontal circumference,	130	133	123	127	130	130	130	126	130	130	126
	Frontal longitudinal arc,	120	139	131	126	122	129	127	124	144	125	132
	Parietal „ „	120	101	120	115	121	119	111	110	104	115	122
	Occipital „ „	370	373	374	368	373	378	368	360	378	370	380
	Total „ „	310	312	304	304	308	307	313	296	317	303	312
	Vertical transverse arc,	34	31	34	30	35	35	35	33	30	...	32
	Length of foramen magnum,	106	106	107	108	102	106	108	98	105	...	104
	Basi-nasal length,	102	108	111	100	...	100	...	96	107	...	...
	Basi-alveolar length,	*96*	*102*	*104*	*93*	...	*94*	...	*98*	*102*	...	...
	Gnathic Index,	133	128	...	131	134	130	134	124	...	132	123
	Interzygomatic breadth,	122	112	118	119	119	114	114	106	108	116	110
	Intermalar „	94	84	86	...	84	90	...	83	85	86	...
	Ophryo-alveolar length,	70	61	65	...	61	69	...	62	65	65	...
	Naso-alveolar „	*71*	*66*	...	...	*63*	*69*	...	*67*	...	*65*	...
	Facial Index,	52	47	50	55	47	52	55	47	50	48	47
	Nasal height,	24	25	24	27	25	26	26	23	25	27	25
	Nasal width,	*46*	*53*	*48*	*49*	*53*	*50*	*47*	*49*	*50*	*56*	*53*
	Nasal Index,	39	36	39	38	37	37	40	34	38	37	35
	Orbital width,	34	34	36	36	33	32	37	32	34	33	33
	Orbital height,	*87*	*94*	*92*	*95*	*89*	*86*	*92*	*94*	*89*	*89*	*94*
	Orbital Index,	58	56	58	...	54	56	...	53	57	54	...
	Palato-maxillary length,	64	...	63	...	64	64	...	55	59	63	...
	Palato-maxillary breadth,	*110*	...	*109*	...	*118*	*114*	...	*104*	*103*	*117*	...
	Palato-maxillary Index,	29	...	...	...	...	...	...	29	...	...	...
Lower Jaw.	Symphysial height,	75	...	...	...	...	...	...	57	...	...	...
	Coronoid „	73	...	...	...	..	...	62	56	...	...	...
	Condyloid „	89	...	...	...	...	...	88	83	...	...	...
	Gonio-symphysial length,	96	...	...	...	...	...	94	80	...	...	...
	Intergonial width,	37	..	...	...	...	...	41	32	...	...	...
	Breadth of ascending ramus,											

of 77 are more difficult to arrange, but on the whole I am inclined to think that they approach more closely in shape to the dolichocephali than to the brachycephali.

For the most part these skulls rested either on the mastoids or occipital condyles, but four touched the table behind with the lower part of the cerebellar fossæ. In each specimen the frontal arc was longer than the occipital. In one the parietal and occipital arcs were equal, in the others the parietal exceeded the occipital. In four skulls the parietal exceeded the frontal. The stephanic diameter exceeded the asterionic except in two specimens, in each of which the asterionic was 1 mm. the greater. In all, the interzygomatic diameter was less than the greatest breadth in the parieto-squamous region. The basi-nasal length was in three cases less than the basi-alveolar. No skull was metopic.

As regards variations in individual skulls, Af. has an epipteric bone in the left pterion, and in the right pterion the squamous temporal articulated directly with the frontal. In three specimens one or at most two small Wormian bones were in the lambdoidal suture. H showed some want of symmetry in the occipito-parietal region, the left half of the occiput projecting behind the right; the cranial sutures were unossified, except the lower third of the left coronal, which was obliterated. In several of the skulls a suture extended from the infraorbital foramen into the floor of the orbit and infraorbital canal.

The vertical index of these mesaticephalic crania was 74 c.c.; in two specimens this index was equal to the cephalic, and in one slightly above it, but in all the other skulls the cephalic index exceeded the vertical. The lowest basi-bregmatic diameter in the female series was 128 mm., the highest 137 mm.; whilst in the male series the lowest corresponding diameter was 134 mm., and the highest 142 mm. The mean height of the female skulls was 132 mm., that of the males 138 mm. One of the skulls was prognathous, three orthognathous, three mesognathous, but the differences in the gnathic index did not correspond in any definite way with differences in the cephalic index, for the prognathous skull N, with a cephalic index 75, had a gnathic index 104, whilst the orthognathous skull T, with the same cephalic index, had a gnathic index of only 94. The nasal and orbital indices also showed a great range of variation, but there was no definite relation between these variations and that of the cephalic index. The mean internal capacity of the nine crania which it was possible to measure was 1405 c.c., *i.e.*, mesocephalic; the mean of six males was 1427 c.c., that of three females 1363 c.c. The mean of each sex was also mesocephalic.

CHATHAM ISLANDERS (MORIORI).

Plate VII. Tables XIII., XVIII., XIX.

Four crania, viz.: three adults and one child were collected. They were presented by the Colonial Museum of New Zealand, and formed a part of the large collection of crania from these islands obtained in 1872 by Mr. Travers. I have examined, along with these crania, three other specimens, also collected by Mr. Travers, which were presented some years ago to the Anatomical Museum of the University of Edinburgh, by Dr. Hector, a skull recently presented by Mr. A. H. Williams, and one from Au nui (great cloud), Wharekauri, on the north side of Chatham Island, formerly belonging to Dr. Handyside, and now in the University Museum. The crania were probably those of six men, two women, and a child, aged about six years.

Norma verticalis.—Most of the skulls had no marked antero-posterior elongation. The parietal tubera were prominent, and gave the appearance of breadth in the parietal region. There was a tendency in some of the skulls to a ridge-like elevation in the sagittal line. The cranial vault was flattened from that line outwards to the tubera, but with not much slope. The sides of the skull were almost vertical below the tubera. All the crania were phænozygous, except that of the child. As a rule the greatest width of the skull was at or near the parietal eminences. In four specimens the stephanic diameter exceeded slightly the asterionic; in four the asterionic was somewhat greater than the stephanic; in one they were equal.

Norma lateralis.—The adults all rested behind on the tips of the mastoid processes, except one, which rested on the occipital crest; but the child's skull touched the cerebellar occipital fossæ. The male crania were massive and heavy, with strong temporal ridges, and marked duplicity of these ridges was observed in the skulls. Owing to the especial prominence of the temporal ridges in the male skulls, these crania had a definite line of demarcation between the upper and lower halves of the parietal bone, so that in the norma occipitalis the skulls had the pentagonal form so well represented by Hyrtl in a Chatham Island skull.[1] One of the male skulls weighed with the lower jaw, 2 lbs. 7 oz. avoir., another 2 lbs. 6¼ oz. The glabella and supraciliary ridges, more especially in one specimen, were projecting, and the frontal bone sloped from them upwards and backwards; the backward slope of the forehead was very marked in several of the males. In two specimens the ophryo-occipital length was 5 mm. less than the glabello-occipital. From a little in front of the obelion the vault sloped downwards and backwards to the occipital point, but there was no evidence of artificial flattening. The occipital squama projected beyond the protuberance, but only very slightly in three specimens. The

[1] Die doppelten Schläfelinien, &c., *Denkschr. d. k. Akad. d. Wiss. Wien*, 1871.

frontal longitudinal arc in each adult male and in one female was greater than either the parietal or occipital; the parietal exceeded the occipital and the occipital the parietal in an almost equal number of crania. In the child the occipital arc was greater than the parietal, and the parietal than the frontal.

The bridge of the nose was fairly well defined and concave upwards and forwards, though in some it was slightly convex at the tip. The nasal bones ranged in length from 21 to 31 mm. and in greatest width from 6 to 15 mm. The nasal spine of the superior maxillæ was distinct, as a rule not very prominent, but in one specimen of considerable size. The junction of the side wall with the floor of the anterior nares was slightly rounded. Three of the crania had the external orbital process prominent, with flattening of the frontal immediately above the process.

In all the adults both the interzygomatic and intermalar diameters exceeded the stephanic and asterionic, and except in one case, where they were equal, the interzygomatic diameter was less than the greatest breadth in the parieto-squamous region. The mean interorbital diameter was 23 mm.; the maximum 26 mm., the minimum 19 mm.

The teeth in all the adults were fully erupted, though many of the sockets were empty. In the aged skulls the teeth were much worn down, but there was no decay. The dentition of the child was that of about six years.

In five specimens the sutures were in course of senile obliteration. When visible they showed no special simplicity in their denticulation. The child's skull had Wormian bones in the pterion on each side, and also in the lambdoidal suture. One adult had one in the right pterion; another one in the left pterion. A male had a large interparietal bone, and in the suture between it and the left parietal were three small Wormian bones. In none did the temporal articulate with the frontal, although the intervening alisphenoid was sometimes very narrow. No cranium was metopic. The os planum was broken in several crania, but had evidently been relatively small, though it retained its quadrilateral form. In the child and in two adults remains of the maxillo-premaxillary suture were seen on the hard palate. There was no subdivision of the malar. In one the left meatus auditorius was almost obliterated in its deep part by an exostosis, but the right was normal. In another a small exostosis projected from the roof of the deep part of the left meatus, but the right was normal. In two males the palate had a depth of 1·7 inch opposite the 2nd molar; in the others its depth was not so great. In one female there was an almost complete pterygo-spheneid foramen; in a male a well-marked third condyle was on the basion, and in the child a right paramastoid process was present. In three of the crania a distinct suture extended from the infraorbital foramen into the floor of the orbit and infraorbital canal. In one adult male there was a pair of rudimentary paramastoid processes.

Four of the adults had the lower jaw, and in each specimen the sigmoid notch was shallow. In three males the jaw was massive with a strong chin, and in two of these

the ascending ramus was high. In the other, a female, the bone was not so strong, and the ascending ramus was much shorter.

The mean cephalic index of the eight adults was 75·2; the range of variation from the maximum 80 (male), to the minimum 72 (male), was 8. The crania were therefore, on the average, just within the mesaticephalic group, although three of the skulls were below 75. The mean vertical index was 73, and the range of variation from the minimum 70 (male)

TABLE XIII.—CHATHAM ISLANDERS (MORIORI).

	Collection,	Chal. A.	Chal. B.	E.U.A.M. A.	E.U.A.M. B.	Whare-kauri,	E.U.A.M. D.	Chal. C.	E.U.A.M. C.	Chal. D.
	Age,	Ad.	Aged.	Ad.	Aged.	Ad.	Ad.	Ad.	Ad.	6th Year.
	Sex,	M.	M.	M.	M.	M.	M.	F.	F.	
	Cubic capacity,	1458	1444	1380	1306	1488	1492	1185	1342	1492
	Glabello-occipital length,	192	190	191	190	191	185	177	184	183
	Ophryo-occipital „	190	188	188	185	186	180	177	182	184
	Basi-bregmatic height,	144	135	134	133	142	142	129	134	123
	Vertical Index,	*75*	*71*	*70*	*70*	*76*	*77*	*73*	*73*	*67*
	Minimum frontal diameter,	104	104	95	92	102	96	92	88	88
	Stephanic, „	116	110	102	107	114	116	101	102	107
	Asterionic, „	114*p*	111*p*	110*s*	110	110	108	101	108	104
	Greatest breadth,	146	138	144	136*p*	146*s*	148*p*	132*p*	137*p*	139*p*
	Cephalic Index,	*76*	*73*	*75*	*72*	*77*	*80*	*75*	*74*	*76*
	Horizontal circumference,	548	532	538	520	542	525	495	508	508
	Frontal longitudinal arc,	140	131	133	130	132	135	117	129	118
	Parietal „ „	119	124	123	124	122	} 253	129	122	120
	Occipital „ „	123	113	132	124	126		106	116	137
	Total „ „	382	368	388	378	380	388	352	367	375
	Vertical transverse arc,	320	301	310	286	315	316	281	290	38
	Length of foramen magnum	34	34	28	32	34	32	30	34	...
	Basi-nasal length,	113	108	103	110	111	104	100	101	89
	Basi-alveolar length,	106	100	103	104	104	102	100	98	80
	Gnathic Index,	*94*	*92*	*100*	*94·5*	*94*	*98*	*100*	*99*	*90*
	Interzygomatic breadth,	144	138	139	130	144	138	132	126	106
	Intermalar „	128	126	120	119	122	130	116	116	94
	Ophryo-alveolar length,	95	94	91	84	102	95	81	86	81
	Naso-alveolar „	76	71	71	63	77	67	61	67	60
	Facial Index,	*66*	*68*	*65*	*65*	*71*	...	*61*	*68*	*76*
	Nasal height,	58	56	60	51	57	51	46	53	44
	Nasal width,	28	25	25	25	26	25	25	25	20
	Nasal Index,	*48*	*44*	*42*	*49*	*46*	*49*	*54*	*47*	*45*
	Orbital width,	40	38	39	40	38	40	38	38	31
	Orbital height,	35	36	37	33	35	32	31	33	33
	Orbital Index,	*87·5*	*95*	*95*	*82·5*	*92*	*80*	*82*	*87*	*106*
	Palato-maxillary length,	58	56	54	54	58	55	53	56	42
	Palato-maxillary breadth,	66	64	65	61	65	64	59	60	57
	Palato-maxillary Index,	*114*	*114*	*120*	*113*	*112*	*116*	*111*	*107*	*136*
Lower Jaw.	Symphysial height,	32	...	...	...	36	30	29	...	23
	Coronoid „	80	...	...	...	84	66	61	...	50
	Condyloid „	69	...	...	...	73	58	61	...	45
	Gonio-symphysial length,	107	...	...	...	102	99	94	...	77
	Intergonial width,	103	...	...	...	100	...	90	...	74
	Breadth of ascending ramus,	41	...	...	...	40	41	43	..	32

to the maximum 77 (male) was 7. In each skull the height was less than the greatest breadth, and the altitudinal index was less than the cephalic index. The crania were metriocephalic.

The mean gnathic index was 96, and the range of variation from the minimum 92 (male) to the maximum 100 (male and female) was 8. The crania on the average were orthognathic, though three specimens were mesognathic. The mean facial index was 66, and the range of variation from 61, the lowest (a female), to 70·8 the highest (a male), was 10. The mean nasal index was 47, and the range of variation from 42 (male), the minimum, to 54, the maximum (female), was 12. On the average they were leptorhine, only two specimens exceeding the highest term of that series. The mean orbital index was 88, and the range from the lowest, 80 (male), to the highest, 95 (male), was as much as 15. The average was mesoseme, but individuals were either micro-, meso-, or megaseme. The mean palato-maxillary index was 113, and the range from 107, the minimum, to 120, the maximum, was as much as 13; the average was mesuranic. The great width of the palato-alveolar region of the child, as compared with the length, was due to the imperfect molar dentition, as only the first pair of true molars were in place.

The mean internal capacity of the adults was 1387 c.c., the mean of six males was 1428 c.c., of two females 1263·5 c.c., both the females were microcephalic. The general of the two sexes, and of the males was mesocephalic; three males were megacephalic and one microcephalic. It is remarkable that the child, of probably the sixth year, should have had a capacity of 1492 c.c.

The Chatham Island skulls were, therefore, on the mean mesaticephalic, metriocephalic, orthognathic, phænozygous, leptorhine, mesoseme, mesuranic and mesocephalic.

NEW ZEALANDERS (MAORI).

Plate VII. Tables XIV., XV., XVIII., XIX.

Three of the Maori skulls collected by the Challenger were presented by the Colonial Museum, Wellington. One of these was marked Waikato tribe, "the modern Maori," North Island; another was labelled East Cape tribe, North Island (Keu, or red haired); the third was labelled Hawea tribe, or Moa Hunter, West Coast, Jackson Bay, South Island. A fourth specimen was presented by Mr. Travers, of Wellington, but the tribal name was not given. Along with the above I have examined a series of seventeen skulls in the Anatomical Museum of the University of Edinburgh. Seven of these specimens were presented by Dr. J. Batty Tuke, who collected them in 1861, in the district of Cook's Straits; six of these crania were obtained on Kapiti, or Entrance Island, which lies on the north side of the western approach to Cook's Strait;[1] one was taken from an old Maori

[1] As the skulls from Kapiti Island are a very interesting series I transcribe from the Museum Catalogue the following notes by their donor, Dr. J. Batty Tuke, who procured them "whilst on a coasting voyage in the schooner

cooking place, the site of a fight which occurred about 30 years ago near Wanganui, north of Cook's Straits. Three specimens were from Otago; two, presented by Mr. W. Riddell, being from Chastlands Mistake, and one found in an oven at Oipopo. One was found in the Marlborough district of the Middle Island, and was presented by Dr. Philip. One presented by Mr. Lambert, was from Whangarii, to the north of Auckland. Three were from the neighbourhood of Auckland, whilst the localities of the remaining two were not known.

Nine of the twenty-one crania were adults and presumably males, nine were adults and presumably females, two were children about 8 and 10, and one was apparently a girl about 16.

Norma verticalis.—In both the males and females the crania were not uniform in appearance in each sex, for some were obviously longer and narrower than others, and did not dip so abruptly in the parieto-occipital region, so that their proportions were dolichocephalic, others were wider in the parietal region and mesaticephalic. In the males the sagittal line was slightly ridged, the parietal eminences as a rule were prominent, and the cranial vault sloped, and was flattened from the ridge to the eminences. The sides of the skull were almost vertical below the parietal tubera. All the skulls, with one exception, were phænozygous. The stephanic and asterionic diameters were equal in one specimen; in four the stephanic exceeded the asterionic; in four the asterionic exceeded the stephanic. In the females the sagittal line, except in three specimens, was not so ridge-like as in the males, and the slope from that line outwards to the tubera was less. All the skulls were phænozygous. The stephanic and asterionic diameters were equal in one specimen; in three the stephanic exceeded the asterionic; in five the asterionic was greater than the stephanic.

Norma lateralis.—Of the male skulls four rested behind on the mastoids; two on the occipital condyles; three on the conceptacula cerebelli. Of the females, three rested on the mastoids; three on the condyles; one on the conceptacula. The male crania were not so massive as those of the Moriori, for the heaviest male skull did not exceed 1 lb. 15 oz. avoir., and the next in weight was 1 lb. $12\frac{3}{4}$ oz. The inion, glabella, and supraciliary ridges were prominent. The forehead was more retreating in the males than in the females, and in the skulls with a relatively high cephalic index the descent from

"Tyne" during October 1861. We were driven by stress of weather under the lee of this island, which was at that time uninhabited except by two white men in charge of a small cattle Station. Two of the skulls (the females?) were found with their skeletons buried under ledges of rock; the others in a cave the descent to which was by a narrow shaft, and which was filled with human bones the amount of which it was quite impossible to compute. I sunk to my waist in them, and should have gone further if not supported, the lower strata being quite disorganised. This cave was the burying place of a hapu or family of the Ngatirankawa Tribe, living at Waikanai and Otaki on the mainland about eight miles distant. All such burying places are strictly held "tapu," or sacred, so that it is beyond suspicion that any of these could possibly be European skulls. Had there been natives on the island it would have been impossible to have secured these specimens. As it was, great difficulty was experienced from the superstition of the English sailors of the schooner. I have been given to understand by competent authorities that no white man had ever been in that cave before."

the obelion into the occipital region was steeper than in the more elongated crania. The occipital squama projected behind the inion, but in some specimens the projection was very slight. In the males the frontal longitudinal arc was in one case equal to the occipital, but in all the other specimens exceeded it. In six cases the frontal exceeded the parietal, in three the parietal arc was the longer. In five the parietal was greater than the occipital. In the females the frontal longitudinal arc was greater than the occipital in all the specimens except one; in two cases the frontal equalled, in four exceeded, and in one was less than the parietal. The parietal arc exceeded the occipital in four specimens, and in two was less than it.

The bridge of the nose was concave upwards and forwards, sometimes with a deep curve, in others slightly convex, near the tip. The nasal bones ranged in length from 20 to 34 mm., and in greatest width from 6 to 11 mm. The skull (Kapiti C) in which the nasal was 34 mm. by 11 mm., was that in which the interorbital diameter was 29 mm. The nasal spine of the superior maxillæ was distinct, though not as a rule very prominent. The anterior nares in some skulls were markedly wider than in others. Many of the crania were flattened in the frontal region immediately above the external orbital process, and this process was therefore prominent. In both males and females the interzygomatic and intermalar diameters exceeded the stephanic and asterionic in the same skull. The relations of the interzygomatic and greatest diameter in the parieto-squamous region were variable; in four cases the interzygomatic exceeded the inter-parietal, in six it was less, and in one it was equal. The interorbital diameter ranged from 21 to 29 mm.

In five skulls the upper wisdom teeth were either not erupted, or were shed, and the alveoli absorbed. The teeth in the aged skulls were much worn, and the crowns flattened but not decayed. From the dentition of the young skulls, they were children apparently of 8, 10, and 16 years.

In six specimens the sutures of the cranial vault had almost disappeared from senile obliteration, and in another they were partially synostosed. In many of the crania the sutures at and near the bregma were very simple in their denticulation. No skull was metopic. Wormian bones were present in several specimens in the lambdoidal suture, and in two crania a pair of large triquetrals occupied the lambda. In one a considerable epipteric bone was in each pterion, and in the child of 8 the left squamous temporal articulated directly with the frontal, but the right did not. The os planum of the ethmoid, though relatively small, was normal in shape. The maxillo-premaxillary suture was faintly seen in several adults, and more distinctly in the children on the anterior part of the hard palate. The malar bone was not divided. In many of the crania, both adults and two of the children, a denticulated suture passed through the inferior border of the orbit from the infraorbital foramen to the roof of the infraorbital canal, immediately internal to the malo-maxillary suture. In one adult the left auditory meatus

was greatly narrowed by a broad based exostosis projecting both from the anterior and posterior walls, whilst in the right meatus a smaller projected from the posterior wall only. Another skull had a similar exostosis from the posterior wall of the right meatus. A female skull had a third condyle at the basion. The dimensions of the lower jaw are given in the table; in no instance was it particularly massive. The intergonial and intersymphysial diameters closely approximated to each other.

The mean cephalic index of the eighteen adult skulls was 74 : that of the nine males 74·4; that of nine females 73. The average was therefore in the upper term of the dolichocephalic series. The range in the males was from 70 to 78; in the females from 67 to 78. As the index of nine was 75 and upwards, these were all mesaticephalic. A child of 8 with a cephalic index of 82 was brachycephalic. The mean vertical index of sixteen adults was 73·5, that of seven males 74·1, that of eight females 72·87. The

TABLE XIV.—NEW ZEALANDERS (MAORI)—MALES.

Collection,	Chal. Waikato.	Kapiti Island, E.U.A.M. A.	Kapiti Island, E.U.A.M. B.	Kapiti Island, E.U.A.M. C.	63c.	5.	Chastlands.	Aucklland.	Marlborough.
Age,	Ad.	Ad.	Ad.	Ad.	Ad.	Ad.	Aged.	Aged.	Ad.
Sex,	M.	M.	M.	M.	M.	M.	M.	M.	M.
Cubic capacity,	1350	1318	1336	1520	....	1526	1356	1494	1586
Glabello-occipital length,	178	179	180	196	195	192	182	194	199
Ophryo-occipital ,,	177	177	174	193	194	189	178	188	196
Basi-bregmatic height,	134	135	136	135	...	150	140	138	144
Vertical Index,	*75*	*75*	*76*	*69*	...	*78*	*77*	*71*	*72*
Minimum frontal diameter,	92	98	92	103	102	100	93	90	99
Stephanic,	112	110	105	110	116	112	110	108	110
Asterionic,	112	100	107	114	113	118	108	116	106
Greatest breadth,	136	140*p*	136*s*	138*s*	142	143	138*s*	146*s*	144*p*
Cephalic Index,	*76*	*78*	*76*	*70*	*73*	*74*	*76*	*75*	*72*
Horizontal circumference,	501	516	504	550	547	532	514	540	542
Frontal longitudinal arc,	126	120	127	130	140	132	133	144	133
Parietal ,, ,,	123	134	110	136	125	139	112	126	130
Occipital ,, ,,	115	110	120	115	...	114	133	118	131
Total ,, ,,	364	364	357	381	....	385	378	388	394
Vertical transverse arc,	304	298	298	310	310	324	308	304	306
Length of foramen magnum,	35	31	32	37	....	35	31	36	40
Basi-nasal length,	104	101	106	109	....	114	104	107	106
Basi-alveolar length,	101	95	103	106	....	110	99	103	97
Gnathic Index,	*97*	*94*	*97*	*97*	....	*96*	*95*	*96*	*91·5*
Interzygomatic breadth,	132	134	137	144	....	146	138	144	....
Intermalar ,,	116	120	124	132	125	128	121	124	129
Ophryo-alveolar length,	94	82	91	98	86	87	88	91	93
Naso-alveolar ,,	67	59	65	75	67	66	65	69	68
Facial Index,	*71*	*60*	*66*	*68*	....	*59*	*64*	*63*	....
Nasal height,	52	50	54	56	55	49	54	54	55
Nasal width,	27	21	28	26	24	28	24	24	26
Nasal Index,	*52*	*42*	*52*	*46*	*44*	*57*	*44*	*44*	*47*
Orbital width,	37	41	37	48	40	39	40	40	40
Orbital height,	35	32	32	36	34	34	36	34	37
Orbital Index,	*95*	*78*	*86*	*75*	*85*	*87*	*90*	*85*	*92·5*
Palato-maxillary length,	55	56	56	58	...	62	56	...	51
Palato-maxillary breadth,	65	57	63	65	....	69	...	67	66
Palato-maxillary Index,	*118*	*102*	*112*	*112*	....	*111*	...	...	*129*
Lower Jaw. Symphysial height,	29	...	...	31	....	35	33	...	...
Lower Jaw. Coronoid ,,	64	...	...	62	....	76	68	...	...
Lower Jaw. Condyloid ,,	63	...	...	61	....	60	60	...	...
Lower Jaw. Gonio-symphysial length,	89	...	...	95	....	88	96	...	...
Lower Jaw. Intergonial width,	84	...	...	96	....	94	96	...	...
Lower Jaw. Breadth of ascending ramus,	36	...	...	38	....	34	43	...	...

general mean as well as that of each sex was metriocephalic. The mean basi-bregmatic height of eight females was 134 mm., the maximum being 140 mm., and the minimum 125 mm. The mean corresponding height of eight males was 139, the maximum being 150 mm., the minimum 134 mm. In the males the height and breadth in two skulls were equal; in four the breadth exceeded the height, in two the height exceeded the breadth. In the females the breadth exceeded the height in four specimens, whilst in the other four the height was greater than the breadth.

The mean gnathic index in the males was 95·4, in the females 97; so that the average in both was orthognathous. None of the males exceeded 97, but one female reached 100 and another 103; both of these, therefore, were mesognathous. The mean nasal index was 47·5 in the males, and 51 in the females; the average in both was

TABLE XV.—NEW ZEALANDER'S (MAORI)—FEMALES.

	Collection,	Chal. East Cape.	Chal. Hawea.	Chal. Wellington.	Kapiti D.	Wanganui. 63a.	Whangarii.	Chastlands.	Aucklland.	Otipopo.	Kapiti E.	Kapiti. F.	Aucklland.
	Age,	Adult.	Ad.	Ad.	Aged.	Ad.	Aged.	Aged.	Aged.	Ad.	Aet. 8.	Youth, Aet. 16.	Aet. 10.
	Sex,	F.?	F.	F.?	F.	F.	F.	F.	F.	F.	...	...	...
	Cubic capacity,	1250	1216	1378	1326	...	1240	1364	1540	...	1472	1308	1405
	Glabello-occipital length,	182	180	182	195	188	180	182	193	180	178	177	177
	Ophryo-occipital ,,	181	178	180	194	188	179	180	189	180	178	179	178
	Basi-bregmatic height,	134	133	136	138	...	125	138	140	130	126	124	134
	Vertical Index,	*74*	*74*	*75*	*71*	...	*69*	*76*	*72*	*72*	*71*	*70*	*76*
	Minimum frontal diameter,	90	90	100	90	94	93	98	93	94	94	90	86
	Stephanic, ,,	98	102	108	103	110	108	114	110	103	111	109	103
	Asterionic, ,,	100	107	112	115	108	108	108	108	106	108	100	106
	Greatest breadth,	130*p*	128*s*	139*s*	130*s*	142	129	141*p*	138*p*	140	146*p*	128	137*p*
	Cephalic Index,	*71*	*71*	*76*	*67*	*75*	*72*	*77*	*71*	*78*	*82*	*72*	*77*
	Horizontal circumference,	502	495	515	534	525	502	512	530	510	507	493	494
	Frontal longitudinal arc,	132	114	127	131	140	...	135	130	124	132	123	130
	Parietal ,, ,,	127	...	127	113	140	...	127	135	110	117	127	125
	Occipital ,, ,,	113	...	126	139	...	...	113	125	122	121	113	116
	Total ,, ,,	372	360	380	383	...	352	375	390	356	370	363	371
	Vertical transverse arc,	298	284	303	300	315	...	310	304	293	304	288	295
	Length of foramen magnum,	31	34	29	36	...	37	33	33	32	36	35	34
	Basi-nasal length,	102	100	100	107	...	99	100	106	104	92	93	92
	Basi-alveolar length,	100	95	95	100	...	102	94	106	...	90	91	85
	Gnathic Index,	*98*	*95*	*95*	*93*	...	*103*	*94*	*100*	...	*98*	*98*	*92*
	Interzygomatic breadth,	120	...	134	...	...	131	134	...	...	120	113	110
	Intermalar ,,	110	114	122	...	114	109	120	116	...	105	103	98
	Ophryo-alveolar length,	98	85	82	92	90	83	83	90	...	80	70	71
	Naso-alveolar ,,	68	63	60	70	66	59	62	69	...	60	52	53
	Facial Index,	*82*	...	*61*	...	...	*63*	*62*	...	...	*67*	*62*	*64*
	Nasal height,	48	44	45	54	55	42	51	51	...	45	41	42
	Nasal width,	23	25	27	24	24	26	26	23	...	20	22	21
	Nasal Index,	*48*	*57*	*60*	*44*	*44*	*62*	*51*	*45*	...	*44*	*54*	*50*
	Orbital width,	35	37	38	40	36	41	40	40	38	35	33	31
	Orbital height,	33	33	33	37	35	34	33	33	36	33	30	31
	Orbital Index,	*94*	*89*	*87*	*92*	...	*83*	*82*	*82*	*95*	*94*	*91*	*100*
	Palato-maxillary length,	55	...	54	54	...	54	49	57	...	52	47	43
	Palato-maxillary breadth,	60	62	61	63	...	59	61	63	...	59	58	60
	Palato-maxillary Index,	*109*	...	*113*	*117*	...	*109*	*124*	*110*	...	*113*	*123*	*139*
Lower Jaw.	Symphysial height,	31	...	29	...	...	30	29	...	...	25	...	...
	Coronoid ,,	65	...	69	...	...	61	67	...	...	53	...	...
	Condyloid ,,	53	...	67	...	...	56	63	...	...	49	...	...
	Gonio-symphysial length,	87	...	91	...	...	80	84	...	...	77	...	...
	Intergonial width,	83	...	89	...	...	83	...	...	...	79	...	...
	Breadth of ascending ramus,	38	...	32	...	...	33	33	...	...	33	...	...

mesorhine; but of the males six were leptorhine and one platyrhine, whilst of the females three were platyrhine and three leptorhine. The mean orbital index in the males was 86, in the females 88; the average in both was mesoseme, but of the males three were megaseme and two microseme; and of the females three were megaseme and three microseme. In the three children the index in each case was megaseme. The mean palato-maxillary index was 114 in the adult males, and 113·6 in the females; in one male the breadth exceeded the length by only 1 mm.; the palato-alveolar region was mesuranic.

The mean internal capacity of fifteen adult crania was 1387 c.c.; eight probable males had a mean capacity of 1436 c.c.; seven probable females of 1330·5. The general mean of the whole series and of the males was mesocephalic; that of the females was microcephalic. Four males were megacephalic, two were microcephalic. Four females were microcephalic and only one megacephalic. Of the young crania, one, aged about eight, was megacephalic.

The characters of these New Zealand skulls may be summarised as follows:—dolichocephalic, but on the verge of mesaticephalic, metriocephalic, phænozygous, orthognathic, mesorhine, mesoseme, mesuranic, and mesocephalic.

COMPARISON OF THE CRANIA OF THE PACIFIC ISLANDERS.

As the collection of human bones formed by H.M.S. Challenger included crania from several of the smaller islands in the Pacific Ocean, I may take this opportunity both of comparing these skulls with each other, and of making a general survey of the cranial characters of the people of the South Sea Islands. Our knowledge of these islanders has been greatly extended of late years by the labours of missionaries, by commercial enterprise, and by the visits of ships-of-war of various nationalities. Numerous descriptions of the people, their physical characteristics, customs, implements, weapons, and language have been written, and crania have been collected and deposited in many European museums. In making this comparison, I shall avail myself both of the crania that I have personally examined and of the published descriptions of skulls so far as I have been able to obtain access to the literature of this subject.

From the descriptions which have been given of the aborigines of the South Sea Islands by numerous travellers, it is now generally admitted that two well-defined races can be recognised. The one, named Papuan or Melanesian, which occupies New Guinea and the smaller islands to the east, south, north, and west. This race is distinguished by its sooty-brown or black skin, black frizzly hair, and well-developed beard. The second, named brown Polynesian or Mahori,[1] which inhabits, as was recognised by Captain Cook, the islands in the more eastern part of the Pacific, from the Sandwich Islands in

[1] This term Mahori is suggested in the article South Sea Islanders, by W. L. Ranken, in *Journ. of Anth. Inst.*, vi. p. 223, 1877; also in Australasia, by A. R. Wallace, London, 1880, p. 261.

the north to New Zealand in the south. This race is distinguished by its light brown or somewhat yellow skin, straight black hair, and scanty beard. To these a third race has been added by the name of Mikronesians, which occupies the Pelew, Caroline, Marshall, and Gilbert Islands, scattered in the north-western parts of the Pacific. By many ethnologists these people are not regarded as a distinct type or race, but as a mixture of the Mahori with the Malay, and in a less degree of Papuan, Negrito, Chinese, and Japanese elements.[1] The Challenger collection included crania both of the Papuan and brown Polynesian races, but none from the islands of the Mikronesian group.

The description by Prof. Moseley of the Admiralty Islanders (p. 52) makes it quite clear that in the black-brown colour of the skin of the adults, and in the frizzled hair, which formed a dense mop, these people presented Papuan characters; though, as regards the hair on the face, bushy whiskers and beard seemed to be the exception.

If their crania be compared with those of the Australians they will be found to differ both in general appearance and in many characters which can only be arrived at by the use of cranio-metrical methods. Thus the Australian skulls were heavier, with thicker walls, stronger ridges and processes for muscular attachment, much more projecting glabella and supraciliary ridges, with consequently a much deeper depression at the fronto-nasal suture, and the appearance of a more receding forehead. Further, the summit of the cranium in the Australians was roof-shaped, and exhibited more distinctly an ill-filled character. Both races were dolichocephalic. When the corresponding measures of the skulls of the Admiralty Islanders and of the Australians measured by myself are compared, it will be seen that the mean length-breadth index was equal in the two peoples, but whilst the males were somewhat higher than the females in the Admiralty Islanders, they were below them in the Australians. The vertical index was higher (72) in the Admiralty Islanders than in the Australians (70); but whilst the difference in the two sexes was very slight in the Australians, it was marked in the Admiralty Islanders, the males being 73, the females 70. Both races were microcephalic as regards their cranial capacity, but whilst the Australians, both male and female, were on the average microcephalic, the mean of the male Admiralty Islanders was mesocephalic. The Australian crania were distinctly phænozygous, the Admiralty islanders as a rule were cryptozygous. The Australians were less prognathous than the Admiralty Islanders. The nasal index was higher in the Australians than in the Admiralty Islanders, so that whilst the former were platyrhine, the latter were on the line between the leptorhine and mesorhine. In both peoples the orbital index was mesoseme, but in the Admiralty Islanders it was slightly higher than in the Australians, in whom it was on the verge of microseme. The palato-maxillary index was higher in the Admiralty Islanders than in the Australians; in the latter it was dolichuranic, in the former mesuranic.

[1] See Mr. A. H. Keane's Appendix, p. 617, to Wallace's Australasia, already quoted.

But the two races differed from each other in important external physical characters. The hair of the scalp, though black in both, was straight and smooth in the Australian, but fine curly in the Admiralty Islander, and formed in him "a dense mop projecting in all directions 6 to 8 inches from the head." The beard and whiskers were as a rule scanty in the Admiralty Islander, but fairly developed in the Australian. In both, the skin was black or black-brown, though Moseley states that the Admiralty Islander youths of both sexes were as a rule much lighter than the adults, and that he saw one man and two women whose skins were of a light yellow colour. The lips were thick and projecting in the Australians, but not unusually large and prominent in the Admiralty Islanders. Prof. Moseley speaks of a well-marked depression usually present at the root of the nose, so that the brow is somewhat overhanging. From the feeble glabella in most of the crania, granting that they belong to the same race as the living islanders, the projecting brow must be due to thickened skin and subcutaneous tissue, whereas in the Australian it is largely produced by the thickening of the frontal bone. In both races the nose was short and with dilated alæ, but the nostrils were not platyrhine in the Admiralty Islanders, whilst in the Australians the plane of their opening was directed downwards, forwards, and outwards; again, about one in every fifteen or twenty Admiralty Islanders had a long Jewish nose. The conclusion therefore to which one has come from this comparison, is that the Australians and Admiralty Islanders are two distinct races.

I shall now pass to the consideration of the characters of the crania of the people occupying the other islands of the Melanesian area. From its size and importance as the chief seat of the Papuans I shall begin with *New Guinea.*

Material for the determination of the cranial characteristics of the people of New Guinea has been accumulating during the last few years. Though still far from perfect, especially as regards the people of the interior, numerous crania are now in European museums, and a large number have been measured and described. MM. de Quatrefages and Hamy have made a critical examination of the literature of this subject up to the date of publication of their fasciculi on the 'Négrito-Papoue' and 'Papoua' races, and have brought together in a form convenient for reference, a mass of information of which I shall avail myself, though at the same time I shall have to refer to other and subsequent writers and to some specimens not previously described. The north-west end of New Guinea is the part of the island from which the greatest number of crania have been obtained, but the southern seaboard, the south-eastern peninsula, the small islands in Torres Straits, and the course of the Fly River, have also contributed important material.

As a result of the examination of the skulls from these several localities it is evident that a considerable variety in form and proportions has been observed, some being decidedly brachycephalic, others mesaticephalic, others dolichocephalic.

We may first inquire into the evidence which has been recorded of the presence of

brachycephalic and mesaticephalic people either in New Guinea or the adjacent islands. MM. Quoy and Gaimard visited, during the voyage of the "Uranie," the islands of Rawak and Waigiou, situated off the extreme north-west of New Guinea, and gave an account of the people.[1] From their description the crania are short, broad, and high, and they state that their heads are flattened both anteriorly and posteriorly, and in the plate accompanying their description, where two skulls of natives of Rawak are figured, both crania are seen to have well-marked parieto-occipital flattening, and although no measurements are given, they are obviously brachycephalic. MM. de Quatrefages and Hamy have described, in more detail,[2] the crania collected in Rawak and in the adjacent islet of Boni. In one skull the cephalic index was 88, and the average of five skulls was 86, so that their brachycephalic character is unquestionable, whilst the parieto-occipital flattening is strongly marked. The crania observed at Waigiou by the naturalists of the "Coquille" are described as remarkable for a considerable posterior flattening, and, from measurements given by M. Garnot, the cephalic index is 81·8.

In 1856 Prof. Retzius stated[3] that the museum of the Caroline Institute of Stockholm had received from Dr. Wise of Edinburgh three crania of brachycephalic Papuans, which had a striking resemblance to each other and to the crania described by MM. Quoy and Gaimard. MM. de Quatrefages and Hamy have pointed out[4] that the crania collected by Wise were of the tribe of Karons, a people occupying a chain of mountains, originally known as Arfak, in the north-west part of New Guinea, parallel to the north coast and adjacent to Port Dorey. A description of these crania has been given by MM. de Quatrefages and Hamy, one of whom visited Stockholm for the purpose of studying them. Two of these three crania were not flattened in the parieto-occipital region, one of which had a cephalic index of 78·8, the other of 78·3. Their volume was not large, the mean horizontal circumference 492 mm., the capacity 1370 c.c. The antero-posterior maximum of the one 175 mm., and of the other 171 mm. The third specimen had, however, a distinct parieto-occipital flattening, and was obviously brachycephalic. Its antero-posterior maximum was the same as the glabello-iniac, 174 mm., the transverse maximum was 146, and the cephalic index was consequently 83·9. Another cranium, from Amberbaki, adjacent to the country of the Karons, collected by M. Beccari, has been described by MM. Incoronato and Toceo.[5] This skull, apparently that of a woman, had a capacity 1243 c.c., and a horizontal circumference 481 mm. Its antero-posterior max. was only 167 mm., its transverse max. 136 mm., and its cephalic index 81·4.

[1] *Annales des Sciences Naturelles*, t. vii. p. 27, pl. iii., 1826. Figures of one of these skulls are reproduced by von Baer in Crania selecta, pl. iii. figs. 4, 5.

[2] Crania Ethnica, p. 210.

[3] Forhand. ved de Skandin. Naturforsk, Christiania, July 1856; and Ethnologische Schriften, Leipzig, 1864, p. 145.

[4] Crania Ethnica, p. 201.

[5] *Archivio per l'Antropologia*, lib. iv., 1874, and *Boll. della Soc. Geograf. Italiana*, 1874, quoted by de Quatrefages and Hamy, p. 204.

Sandifort has also described[1] a brachycephalic Papuan cranium with a cephalic index of 85, and one with a cephalic index of 83 is in the collection (No. 1401) of Dr. Barnard Davis,[2] but the exact localities from which these skulls were procured does not seem to have been ascertained.

In the magnificent collection of crania formed by Dr. A. B. Meyer[3] certain skulls possessed a high cephalic index. Of the twenty-three crania obtained by him from Rubi, near to the south end of Geelvink Bay, three had the indices respectively of 77·7, 76·4, 76·4; and of the one hundred and twelve skulls collected at Kordo, on the island of Mysore, at the mouth of the same bay, several had an index above 75. From an analysis which Dr. Meyer has made of the "normal" series of one hundred and thirty-four crania, one hundred and two have a length-breadth index below 75, twenty-five between 75 and 80, and three only above 80; whilst of the adult crania, eighty-six in number, it would appear that of fifty-four males, forty-three had a cephalic index below 75, nine between 75 and 80, and two above 80; and of thirty-two females, thirty were below 75 and two between 75 and 80. These "normal" crania gave no evidence of premature ossification of sutures, or of deformity produced by artificial means. They are considered by Dr. Meyer to be Papuans, and not to contain any mixture of Malays; whilst on Waigiou partially, and on the smaller Papuan islands more to the west, there is, he says, an undoubted mixture of Malays and Papuans.

In 1874 Miklouho-Maclay described[4] three crania, which he had collected in 1872 at the villages of Englam, Mana, and Gumbu on the Maclay coast of New Guinea. He says that the skulls were remarkably brachycephalic, their indices being respectively 81·2, 82·5, and 86·4. In another paper[5] he stated as the result of a great number of measurements that the cephalic index of the New Guinea skulls varied from 62 to 84.[6] Of two skulls collected in Astrolabe Bay on the north-east coast of New Guinea, described by Prof. Virchow,[7] one is said to have a length-breadth index of 78·2, whilst the other is very prognathic, and long and narrow, so that its breadth index is only 72·7. M. Mantegazza has also given evidence of the occurrence of brachycephalic crania amongst the Papuans.[8] These crania, according to him, are small, with large parietal

[1] Tabulæ Craniorum. [2] Thesaurus Craniorum, p. 305.

[3] Dr. Meyer's important memoirs are contained in the *Mittheilungen aus dem k. Zoologischen Museum zu Dresden*, May 1875, October 1876, and December 1878.

[4] Verhand. der Berliner Gesell. für Anthropologie, in *Zeitschr. für Ethnologie*, Bd. vi. p. 177. The name of this Russian traveller is sometimes printed Miklucho-Maclay, at others as in the text.

[5] *Natuurk. Tijdschrift*, Batavia, xxxiv. p. 345, 1874.

[6] In a communication made to the Berlin Society of Anthropology (*Zeitschr. für Ethnologie*, Bd. xii. 374, 1880), and to the Linnean Society of N. S. Wales, *Nature*, vol. xxiv. June 16, 1881, Miklucho-Maclay gives as a result of his travels in Melanesia, that brachycephalism has a much wider range than is usually supposed. He has measured both skulls and heads, and states that the breadth index in many cases exceeds 80 and sometimes 85.

[7] Verhand. der Berlin. Gesell. für Anth., in *Zeitschr. für Ethnologie*, Bd. v. S. 70, 1873.

[8] Studii antropol. ed etnog. sulla Nuova Guinea, 1877; Abstract in *Jahresb. der Anat. und Phys.*, 1881, p. 361. In the *Bull. de la Soc. d'Anthrop.*, 19th Feb. 1880, he says that in d'Albertis's collection are skulls of the Negrito type, brachycephalic in proportion.

eminences, and the mean index of eight skulls was 83·1. Of the fifteen crania collected by Dr. Comrie on the south-east coast of New Guinea, thirteen of which are now in the Museum of the Royal College of Surgeons, London, and the measurements of which are given by Prof. Flower,[1] one from Traitor's Bay, near Riche Island, and another from Lydia Island, have cephalic indices respectively 81 and 82·5, whilst a third from the D'Entrecasteaux Islands has an index 77. The two remaining crania were presented by Dr. Comrie to the Anatomical Museum of the University of Edinburgh. The one from Possession Bay has a cephalic index of 68; this skull is markedly dolichocephalic. The other, from D'Entrecasteaux Island, has a cephalic index of 80·5, so that it falls within the numerical brachycephalic index.[2] Three other skulls in the College of Surgeons Museum, one of which is from an island in Torres Straits and two from Airds River, Gulf of Papua, have also brachycephalic proportions.

Brachycephalic crania have also been procured on Warrior Island (l'île Toud) in Torres Straits. I described and figured one with well marked parieto-occipital flattening from this island in 1880,[3] which had a cephalic index 88 and a vertical index 78; and MM. de Quatrefages and Hamy had previously described and figured from the same island crania with brachycephalic proportions. The well-known Italian traveller Signor D'Albertis has figured[4] a number of the skulls which he collected in his expeditions, and these have now been carefully measured and described by MM. Mantegazza and Regalia.[5] Of the twelve crania collected on Kiwai Island at the mouth of the Fly River, ten had a length-breadth index of 76 or upwards, and of these four were upwards of 80, four between 77 and 80, and two between 76 and 77. Of the four crania collected on Canoe Island, a little higher up the same river, three had the cephalic indices 88·9, 85·8, and 80·8, whilst one was 76·1.

From the examination of the living people of New Guinea, made by M. Jacquinot, from the casts of the head taken by M. Dumoutier, from the description of several of the crania given by MM. de Quatrefages and Hamy, from the configuration of the Warrior Islander skull described by myself, from the photographs of a skull from Canoe Island and one from Kiwai in the D'Albertis collection published by MM. Mantegazza and Regalia, there can, I think, be no doubt that the practice of artificially flattening the back of the head, and in the Canoe Island and Kiwai skulls the forehead also, prevails to a considerable extent amongst individuals, and, it may be, also tribes of the natives of

[1] Catalogue of Crania, p. 218, *e. s.*

[2] The measurements of these skulls are given in Table XVI., p. 89.

[3] Two Masks and a Skull from islands near New Guinea, *Journ. Anat. and Phys.*, July 1880, vol. xiv. p. 479. The measurements are given in Table XVI. *supra*. In the British Museum is a prepared and decorated skull marked "Native chief of Nagheer Island, Torres Straits," with a wooden nose, and with the orbits filled up just as in the skull which I have described from Warrior Island. It was flattened both frontally and occipitally, and obviously brachycephalic.

[4] New Guinea, What I did, and what I saw, London, 2nd ed., 1881.

[5] *Archivio per l'Antropologia e la Etnologia*, lib. xi. Fasc. 2, 1881.

New Guinea and the adjacent islets, as far apart as Waigiou and Rawak on the west, Warrior Island on the south, and apparently D'Entrecasteaux Island on the east. At the same time there can be no doubt that this practice does not prevail generally in all the people of New Guinea, as numerous crania of dolichocephalic proportions have been examined in which there is no evidence of artificial parieto-occipital flattening. It should also be stated that many of the skulls possessing high cephalic indices have also been characterised by distinct parieto-occipital or frontal flattening, and the influence which artificial pressure, applied during infancy to the frontal and occipital regions, has exercised either in producing or exaggerating brachycephalic proportions is a factor which should not be left out of consideration in the study of these crania.

The evidence of the presence of a dolichocephalic people in New Guinea is also very complete. MM. de Quatrefages and Hamy have critically examined the older literature on this subject. In the north-west, Port Dorey, Mansinam, Salwatti, the Wandessa tribe of Geelvink Bay, the island of Jobie at the mouth of the same bay, have all furnished crania of these proportions. Dr. Meyer's collection from Rubi, although, as already stated, containing three mesaticephali, had twenty skulls with a length-breadth index below 75. The collection formed by the same energetic naturalist in Kordo, Mysore, had a very large proportion of the skulls dolichocephalic. In his analysis of the eighty-six "normal" adult skulls, Dr. Meyer states that, of the fifty-four males, forty-three were below 75, and of the thirty-two females, thirty were below 75. In the mountains of Arfak also a dolichocephalic people reside, and MM. de Quatrefages and Hamy give, in their twenty-fifth table, 69·3 as the length-breadth index of five males, and 73·9 as the corresponding index of two females. Even on the small Warrior Island dolichocephalic skulls were obtained by the naturalists on board the "Astrolabe" and "Zelée." MM. de Quatrefages and Hamy state (p. 254) that eight crania from this island exhibited purely Papuan characters; seven of these were males, and they have a mean cephalic index of 71·8 and a mean vertical index of 73·3. A ninth skull again gave a mixture of Papuan and Negrito-Papuan characters. The majority of the crania collected by Dr. Comrie during the voyage of the "Basilisk" on the south-east coast of New Guinea were markedly dolichocephalic. Dolichocephalic skulls from Erroob or Darnley Island and from Wallis Island, Endeavour Strait, are in the Museum of the Royal College of Surgeons. The D'Albertis collection of crania, measured by MM. Mantegazza and Regalia, contains twenty-one skulls, thirteen males and eight females, from the interior of New Guinea, collected from houses on the banks of the Fly River; the maximum cephalic index in these specimens was 77 and the minimum 67·7, and both were males; the mean of the series of males was 71·9, that of the females was 72·5. Two male crania from Baduhubere, an inland place to the west of the mouth of the Fly River, had the cephalic index of 66·1 and 75·8. Of the Kiwai group of skulls already referred to (p. 86), only two had a cephalic index below 75, and the lowest index of the Canoe Island group was 76.

The Anatomical Museum of the University of Edinburgh has recently acquired some skulls from New Guinea, to which I may now refer. To the Rev. S. Macfarlane I am indebted for a specimen from Jarvis Island,[1] Torres Straits, and from a former pupil, Mr. A. F. Davenport, I have received two specimens from Tomara, Cloudy Bay, on the south-east coast.[2] The principal dimensions, along with those of the two specimens presented by Dr. Comrie, referred to on p. 86, and the Warrior Islander, are given in Table XVI. The Jarvis Islander and the adult from Tomara were both distinctly dolichocephalic; whilst the young child from the latter place was brachycephalic, and its greater breadth was obviously due to an essential difference in the proportions of the skull, and not to a mere difference in age. In the Jarvis Islander the vertex was roof-shaped. The skull was smeared with a red pigment. A broad tongue of the squamous temporal, 19 mm. in vertical diameter, joined the frontal; the antero-posterior diameter of the temporal fossa was only 102 mm. The vertical and cephalic indices were equal, and there was marked prognathism and an unusually low palato-maxillary index. In the adult Tomara skull a process of the squamous temporal, 6 mm. in vertical diameter, articulated with the right frontal, whilst two epipteric bones were in the left pterion. The Tomara child's skull had a steep descent from the obelion into the occipital region as if from artificial flattening.

There is now on record also a considerable body of evidence to enable one to come to some conclusion as to the relations of the vertical to the cephalic index in the New Guinea skulls. The mesaticephalic Karons tabulated by MM. de Quatrefages and Hamy, in their Table XX., had for the male a vertical index of 74·2 and for the two females a mean vertical index of 75·73, as against the cephalic indices 78·8 and 79·8 respectively. The brachycephali from Rawak and Boni, in the same table, with a mean cephalic index 86·4, had a length-height index 82·7. A brachycephalic skull from Lydia Island, East Cape, Comrie collection, cephalic index 82, had a vertical index 76, and in a D'Entrecasteaux specimen from the same collection (my Table XVI.) these indices were equal. In my Warrior Island skull, and in the brachycephalic specimen in the Paris Museum, the cephalic index was much above the vertical, and these specimens were distinctly deformed from artificial flattening. The brachycephali and four of the mesaticephali from Kiwai and Canoe Island had the vertical index markedly below the cephalic, and in two only of the mesaticephali had the vertical index the superiority. Hence it would appear that in the crania with high cephalic indices the greatest transverse breadth was as a rule in excess of the basi-bregmatic height.

In the dolichocephalic Papuan crania, on the other hand, an opposite condition

[1] This skull was procured from the Sacred House on Jarvis Island. It was probably the skull of a head taken in battle.

[2] These specimens were collected by Lieut. Thos. de Hoghton of H.M.S. "Beagle." They were found in a native's house.

of these indices would appear to prevail. From MM. de Quatrefages and Hamy's twenty-fourth table, which includes Dr. Meyer's Rubi and Kordo crania, along with specimens from Dorey, Salwetti, Wandessa, and Jobie, the mean vertical index, except in the Jobie skull, exceeded the cephalic, and a similar relation is shown in the male Arfaks, though not in the female, measured in their twenty-fifth table. Eight dolichocephalic skulls in Dr. Comrie's collection in the Museum of the Royal College of Surgeons had the vertical index greater than the cephalic, in one it was less, and in two mesaticephali these indices were equal. In three of the five Erroob crania measured by Prof. Flower the vertical index exceeded the cephalic. In the pure Papuan male crania from Warrior

TABLE XVI.—NEW GUINEA.

Collection,	Warrior Island, Torres St.	Jarvis Island, Torres St.	Possession Bay, Dr Comrie.	D'Entrecasteaux Island, Dr C.	Tomara, Cloudy Bay.	Tomara, Cloudy Bay.
Age,	Adult.	Adult.	Adult.	Adult.	Adult.	Child, 6 or 7.
Sex,	M.	M.	...	F.	...	...
Cubic capacity,	1534	1230	...	...	...	1430 *ap*
Glabello-occipital length,	175	178	178	169	179	172
Ophryo-occipital „	173	176	178	170	178	172
Basi-bregmatic height,	137	130	...	136	...	125
Vertical Index,	*78*	*73*	...	*80·5*	...	*73*
Minimum frontal diameter,	103	90	90	96	94	87
Stephanic „	122	105	106	110	104	114
Asterionic „	120	106	101	103	100	108
Greatest parietal breadth,	154	130*s*	122*s*	136*s*	124*p*	142*p*
Cephalic Index,	*88*	*73*	*68·5*	*80·5*	*69*	*82·6*
Horizontal circumference,	515	494	488	489	494	498
Frontal longitudinal arc,	130	122	122	125	118	124
Parietal „ „	135	132	128	138	127	128
Occipital „ „	109	106	...	...	...	108
Total „ „	374	360	...	...	...	360
Vertical transverse arc,	330	280	280	293	277	310
Basi-nasal length,	105	99	...	94	...	90
Basi-alveolar length,	107	108	...	90	...	88
Gnathic Index,	*102*	*109*	...	*96*	...	*98*
Interzygomatic breadth,	140	122	122	128	...	109
Intermalar „	125	113	112	111	...	103
Ophryo-alveolar length,	90	90	89	78	81	73
Naso-alveolar „	65	68	68	60	60	59
Facial Index,	*64*	*74*	*73*	*61*	...	*67*
Nasal height,	47	46	47	46	44	43
Nasal width,	24	24	22	22	25	20
Nasal Index,	*51*	*52*	*47*	*48*	*57*	*46·5*
Orbital width,	...	39	38	37	36	35
Orbital height,	...	29	31	34	33	31
Orbital Index,	...	*74*	*82*	*92*	*92*	*88·6*
Palato-maxillary length,	64	65	58	52	52	45
Palato-maxillary breadth,	69	62	63	66	57	...
Palato-maxillary Index,	*108*	*95*	*108·6*	*127*	*109·6*	...

Island in the Paris Museum, the basi-bregmatic height exceeded the greatest transverse diameter, but in a female skull from the same island the opposite relation occurred. In nine of the thirteen male crania from the inland district of the Fly River collected by D'Albertis the vertical index was above the cephalic, but in three only of the eight female crania did a similar relation prevail.[1]

So far then as one can base conclusions on these characters of the crania, two very distinct types of skulls have been procured in New Guinea, which must without doubt be regarded as indicating the presence in and around that island of more than one race of men. The testimony of several travellers points also to a similar conclusion. The Rev. S. Macfarlane, who for so many years has been engaged in missionary work amongst these people, states[2] that the bush tribes are greatly inferior both mentally and physically to the coast tribes, and that the latter have driven the aboriginal bush tribes into the interior. Signor d'Albertis makes frequent reference[3] to differences which he observed both in the form of the head and in the customs of the people of the interior and those of the coast. He regards it as certain that many races or varieties have come in contact, and that they are more or less mixed in the district of the Fly River. To all appearance the aborigines of New Guinea, who are most numerous and most widely diffused throughout the island, are a dolichocephalic people, constituting the Melanesian or Papuan element, which probably preserves its purity in the interior of the island; though from the great preponderance of dolichocephalic skulls obtained by Dr Meyer from Rubi and Mysore, it is also obvious that there are parts of the coast where skulls of this type abound.

But from its geographical position New Guinea is on the high road between the Pacific and the Indian Oceans, and a stream of migration both from the west and from the east seems to have flowed around its shores. From the east it has received without doubt colonies of brachycephalic Polynesians, who have occupied the Louisiade Archipelago and the adjacent coasts of the main island. From the west it has been, and is indeed at the present day, visited by the brachycephalic Malays for purposes of trade, who have established themselves at Salwatti and the adjacent parts of the west coast. To the west it is also brought into relation with the brachycephalic, short-statured Negrito. In some localities on the seaboard, or the adjacent small islands, immigrant races may have entirely displaced the aborigines; in others it is not unlikely that an intermixture of a foreign with the proper native Papuan race may have taken place, and according to the extent of that intermixture would the physical characters and the customs of the people of the locality undergo a modification. The presence of a Negrito element in New Guinea, more especially in the mountainous district in the north-west, has also been strongly insisted on by MM. de Quatrefages and Hamy, and the brachycephalic Karons (p. 84) are regarded by them as exhibiting characters which closely

[1] See Mantegazza and Regalia's third table.

[2] *Athenæum*, December 2, 1876.

[3] New Guinea, vol. ii.

approximate to the Negrito race. It is of course a question for consideration whether the Negritos or the Papuans are the primitive inhabitants of New Guinea. The Papuans are undoubtedly the more vigorous race, and it is not unlikely that they may have to a large extent displaced and driven to the mountains, or perhaps somewhat intermingled with, a more feeble pre-existing Negrito population.

There is, however, in the study of the crania collected in New Guinea, an element of uncertainty which should not be lost sight of; as, from the practice of head hunting and preserving, it is not possible to pronounce definitely whether those skulls collected by several travellers, which had been preserved as trophies, really belonged to the race occupying the spot where the skulls were obtained, or had belonged to people of some other tribe or race conquered in war. The Rev. S. Macfarlane has given an interesting explanation of how it is that in these trophies the lower jaw so seldom accompanies the skull, for the man who first wounds the enemy gets the one, whilst he who kills and beheads him gets the other. It will require therefore a more intimate knowledge of New Guinea than we yet possess to enable ethnologists to state precisely the exact distribution of the brachycephalic and dolichocephalic races in that island, and this result can only be attained with accuracy when a sufficient number of skulls known to have belonged to the people occupying each district has been obtained.[1]

The Australian race, though separated by a strait only about 80 miles wide at Cape York from New Guinea, has not apparently exercised any influence there. For the northern Australians, although they make canoes, are not a seafaring people, and they are much inferior in civilization to the Papuans. There is indeed one island in Torres Straits, Kowrarega, inhabited according to Macgillivray[2] by a mixed race, formed by a complete fusion of the Papuans with the Australians. The Papuans, on the other hand, do seem to have somewhat modified the characters of the tribes inhabiting the north coast of Australia. Mr. Paul Foelsche, who lived for a number of years in the Northern Territory of Australia, states[3] that the hair of the head of the men is invariably thick and curly, and he has met with instances where it strongly resembles that of the Papuans, but these are very rare. In the women, as a rule, the hair is with few exceptions not so curly as that of the men.

The archipelago immediately to the north and east of New Guinea, of which the Admiralty Islands form almost the western limit, is also inhabited by a Melanesian people.

The people of *New Britain* are, according to Dr. Finsch,[4] pure Melanesians, their hair

[1] Dr. O. Finsch in his Anthropologische Ergebnisse, 1884, expresses his belief that the people of the south-east coast from Fresh Water Bay to Keppel Bay, also those of the islands in Torres Straits, of Saibai Island and of Salwatti in the extreme north-west, are all of the same race, *i.e.*, pure Melanesians.

[2] Voyage of the "Rattlesnake," 1852.

[3] Notes on the Aborigines of North Australia, *Trans. and Proc. of Roy. Soc. of South Australia*, Adelaide, 1882, p. 1.

[4] Anthropologische Ergebnisse einer Reise in der Südsee, Berlin, 1884.

and skin being characteristically Papuan. The Godeffroy Museum in Hamburg contains one hundred and fifty skulls from the New Britain Archipelago, twenty-six of which are from the principal island, New Britain, and one hundred and twenty from the small island Mioko in the Duke of York group. These skulls have been examined and their characters analysed by Dr. Rud. Krause.[1] The chief measurements are as follows:—the mean length 181 mm., maximum 195, minimum 165; the mean greatest breadth 130·9, maximum 142, minimum 119; the mean height 137·6, maximum 150, minimum 128. The indices are as follows:—length-breadth 72·3, length-height 76, breadth-height 105·1. The cubic capacity varies from 1530 to 990, that of the males having a mean of 1267 c.c., that of the females of only 1180 c.c. Prof. Virchow states[2] that he has been put in the position of obtaining through Dr. Finsch one hundred and fifty crania from New Britain. He refers to the great variation in their cubic capacity, and cites a male skull having a capacity of 2010 c.c. and a female of only 1140 c.c., but he gives no other measurements.

New Hanover and *New Ireland*, situated to the north and west of New Britain, were visited in 1875 by the Prussian war-ship "Gazelle," and a description of the people and their customs has been written by Captain Strauch.[3] From the character both of the hair and skin they are evidently in the main Papuans, though it is possible that here, as elsewhere in the Melanesian Islands, there may have been some intermixture of Mahori blood. Numerous crania were collected, which are now in the Anatomical Museum of the University of Berlin. The majority have been measured by Dr. Rabl-Rückhard, and their characters are recorded by him.[4] I am indebted to that gentleman for an early proof of his important communication. The skulls from New Ireland were collected at a spot which had been used for cannibal feasts, and they were so defective that a proper series of measurements could not be taken. Forty-five specimens belonged in all probability partly to New Britain and partly to New Hanover, but in the table of measurements they are all placed under the heading New Hanover. Dr. Rabl-Rückhard has measured the greatest length from both the fronto-nasal suture and the glabella, and has given the cephalic index in relation to both these measurements. When the glabello-occipital diameter is used to compute the cephalic index, I find that by far the greater number of these skulls have a length-breadth index of less than 75, as many indeed as seventeen being below 70, whilst only six are above 75, and the highest of these is 77·6. These people therefore are undoubtedly dolichocephalic. It is also important that in only one instance was the vertical index below the cephalic, and in only one were they equal; in all the other skulls the vertical index exceeded the cephalic, and in many specimens in a

[1] Die ethnographisch-anthropologische Abtheilung des Museum Godeffroy, Hamburg, 1881.
[2] Versamml. der deutschen Anthrop. Gesellsch., 1882, reported in *Archiv für Anthrop.*, Bd. xiv., 1883, p. 89.
[3] *Zeitschrift für Ethnologie*, Bd. ix. pp. 9, 81, 1877.
[4] *Archiv für Anthropologie*, Bd. xv., 1884, parts 1 and 2, supplement.

very marked manner, as may be seen in the following examples:—C.I. 68·9, V.I. 77·6; C.I. 68·1, V.I. 80·2; C.I. 76·5, V.I. 79·3; C.I. 64·9, V.I. 74·2; C.I. 71·3, V.I. 81·3. In this series of skulls Dr. Rabl-Rückhard regards fourteen as men, six as women, whilst the sex of the remaining twenty-five could not be determined with accuracy.

Skulls, preserved heads, and busts from the *Solomon Islands* are in several museums. Mr. Webster describes[1] the natives of San Christoval as almost black, with woolly hair and Papuan countenances. Captain Strauch states that the people who visited the "Gazelle" at Bougainville were well built, extremely dark, with compact hair sticking far out. But mingled with the people possessing Melanesian characters other travellers have seen natives with fairer skins and long smooth hair, resembling the Mahori or Polynesian race.[2] Four busts of natives of the island Isabel are in the Dumoutier collection in the Paris Museum. They exhibit, as MM. de Quatrefages and Hamy have shown, two distinct types; the one brachycephalic, the other dolichocephalic. Prof. Virchow saw on board a ship in Hamburg a native of the island Morissi.[3] His skin was coloured a rich, shining blackish-brown, almost chocolate. The hair of the head was short, frizzly, black, without, however, being arranged in bunches. The length of the skull was 174·5 mm., its greater breadth 145·5, giving an index 80·2.

Skulls or preserved heads are in the Barnard Davis collection, the Godeffroy Museum, the Museum of the Royal College of Surgeons, the Paris Museum, and that of the University of Edinburgh.[4] Of these thirteen specimens, four have the cephalic indices respectively 75, 76·3, 76·5, 79; whilst the remaining eight are below 75, and have a mean length-breadth index 71. In eight specimens the height of the skull has been measured and the vertical index computed. In the skull with the cephalic index 79, from Makira, in the Barnard Davis collection, the vertical index was also 79, and in one from Isabel measured by Prof. Flower the two indices were respectively 75 and 75·6, but in the other specimens the vertical index decidedly exceeded the cephalic. The skulls, though in the main dolichocephalic, yet present individual specimens which approximate to the brachycephalic standard. In this respect the crania bear out the statements of travellers that whilst the people are mainly Papuan, another race is intermingled with them.

New Caledonia lies to the southward of the Solomon Islands, and the people in their hair and skin have strong Papuan features. The Rev. G. Turner says[5] that the people

[1] The last cruise of the "Wanderer," Sydney, 1863, cited in Thesaurus Craniorum.

[2] Die Inseln des stillen Oceans, by Prof. Meinicke, p. 160, Leipzig, 1875.

[3] Verhandl. der Berliner Gesellsch. für Anthrop. in *Zeitschr. für Ethn.*, Bd. ix. p. 241, 1877.

[4] Two preserved heads from Rubiana, a small island about seven miles to the northward of Rendova Bay in New Georgia, one of the Solomon Islands, were presented to me by Dr. J. C. Cox of Sydney, and are now in the Anatomical Museum of the University of Edinburgh. They were procured by Lieut. Farie, who wrote to me that the Rubiana men are fierce and warlike. Probably these heads are trophies, and may have belonged to natives of New Georgia, with whom the Rubianans are frequently at war.

[5] Samoa, a hundred years ago, p. 340, London, 1884.

resemble the Fijians in colour and figure, though the dialects are widely different. Owing to the colonisation of this island by the French, numerous crania are deposited in museums in that country; the Barnard Davis collection contains a few specimens; two specimens were collected by the "Novara"[1] and six specimens are in the Senckenberg Museum in Frankfort.[2] M. Bourgarel has also made a communication on the skulls of these people.[3] Dr. Bertillon has described the crania in the Museum at Caen,[4] and the fine collection in the Museum of Natural History in Paris has been carefully studied by MM. de Quatrefages and Hamy.[5]

The last-named authorities separate the skulls into two groups, those which belong to the Kanala and other tribes living in the north-east of the island, and those from tribes elsewhere, more particularly in the west. The Kanala crania show certain differences in proportion as compared with the tribes in the west. Thus twenty-five males have a mean cephalic index 71·3 and a mean vertical index 75·1, and twenty-six females have a mean cephalic index 74·4 and a mean vertical index 75·5; whilst the more western tribes have in forty-three males a mean cephalic index 69·6, and a mean vertical index 74·4, and twenty-eight females have a mean cephalic index 72·4 and a mean vertical index 74·7. All are dolichocephalic, but this character is more pronounced in the tribes of the west than of the east. In all, the vertical index dominates over the cephalic, and the greater relative height of the skull is more strongly marked in the western than in the north-eastern tribes. These and other differences in the cranial characters of the people in New Caledonia, MM. de Quatrefages and Hamy ascribe to the intermixture of Polynesian immigrants during the last century. Three crania in the Barnard Davis collection from the northern extremity of this island[6] have the following indices respectively—cephalic 72, 72, 78; vertical 74, 85, 80.

The people of the Isle of Pines, a dependency of New Caledonia, are also in the main dolichocephalic. MM. de Quatrefages and Hamy, in their twenty-eighth table, state that seven males have a mean cephalic index 67, and a mean vertical 72·2; six females have a mean cephalic 68·5, and a mean vertical index 73·4. The skull in the Barnard Davis collection, and six specimens in the Museum of the Royal College of Surgeons, are all dolichocephalic, except one specimen, the cephalic index of which is given by Prof. Flower as 76; but in all the height exceeds the breadth. De Quatrefages and Hamy mention that some crania recently received from this island resemble more those of

[1] See Zuckerkandl's Report in Reise der Novara, Anthropologischer Theil. The one which he has measured has a cephalic index 73·4.

[2] See Schaaffhausen's measurements in Supplement to *Archiv f. Anthrop.*, Bd. xiv. The mean cephalic index of the six specimens is 70·4; the mean vertical index 76·2.

[3] *Bull. and Mém. Soc. Anthrop. Paris*, t. i. of each.

[4] *Revue d'Anthropologie*, t. i. p. 250, 1872.

[5] Crania Ethnica, p. 284.

[6] Thesaurus, p. 308, Nos. 682–84.

the Polynesians than those of the Papuans, and they refer to a tradition that some generations ago a small colony of Polynesians settled there.

The *Loyalty Islands* lie a little to the west of New Caledonia. They are for the most part inhabited by Melanesians, though Polynesians have settled there. The Rev. G. Turner says that the people resemble the Fijians. Four crania from the island Maré occur in museums—a female in the Barnard Davis collection, a female in the Museum of the Anthropological Society of Paris, and a male adult and a child in the Anatomical Museum of the University of Edinburgh.[1] These skulls are all markedly dolichocephalic, the mean breadth index is 69, and this dolichocephalic character is quite as strong in the child's skull as in those of the adults. In all the specimens the vertical index was very decidedly above the cephalic.

As no male skull from Maré has yet been described, I shall state briefly the chief characters of my specimen. Its length, narrowness, and relative height are well seen from the measures in Table XVII. The temporal fossa was remarkably elongated, its antero-posterior diameter being 138 mm., and its vertical diameter 88 mm.; this was largely due to the great antero-posterior growth of the parietal bone, the longitudinal arc of which was 150 mm., and even in the child's skull the corresponding arc of that bone was 142 mm. The gnathic index was 103, or just within the prognathic group. The nasal index was mesorhine, the orbital index mesoseme, and the palato-maxillary index dolichuranic. The antero-posterior diameter of the ascending ramus of the lower jaw was very marked, and that of its coronoid process was equally so, obviously in correlation with the great breadth of the temporal muscle. The sigmoid notch was relatively shallow, and there was no disproportion between the coronoid and condyloid height: the chin was almost vertical; the gonio-symphysial length considerably exceeded the intergonial width. Each pterion had a large epipteric bone: small Wormians were in the lambdoidal suture. Indications of an infraorbital suture were on the left side, and the remains of the frontal suture were seen in the glabella.

Many more crania have been obtained from Lifu: two are in the Barnard Davis collection, four in that of the Museum of the Royal College of Surgeons, and twenty-nine in museums in Caen and Paris. The mean measurements of these twenty-nine skulls are given by MM. de Quatrefages and Hamy in their twenty-seventh table. The mean breadth index of eighteen males is 69·8, the height index 73·5; the breadth index of eleven females is 71·8, the height index 74·5. As the measurements of individual skulls are not given, one cannot gather what the maximum indices were in this series, but from Prof. Flower's measurements of the skulls in the Royal College of Surgeons it is clear that Lifu crania may attain a breadth index approaching the brachycephalic, two adults being respectively 78·3 and 78·9, and a child 80·6. Ouvea is said to have been colonised

[1] I am indebted for these specimens to my friend Dr. J. C. Cox of Sydney. Their measurements are recorded in Table XVII.

by Polynesians who migrated there some generations ago, but the three crania in the Natural History Museum in Paris from this island are said by MM. de Quatrefages and Hamy to be strongly Papuan in character, and to have a mean breadth index 68·2 and a mean height index 71·9.

The *New Hebrides, Banks's Islands*, and the *Santa Cruz Islands* form a very extensive archipelago to the north of New Caledonia and the Loyalty Islands. They are inhabited by people varying in stature, physiognomy, and colour of skin; some having strong Papuan characters, but others presenting modifications which point to an intermixture of races. The Rev. George Turner describes the men of Tanna as having less of the negro cast of countenance than some of the other Papuans, but their hair is frizzled; the Erro-

TABLE XVII.—SOUTH SEA ISLANDERS.

	Collection,	Loyalty Islands.		New Hebrides, Erromanga.				Malli-collo.	Solomon Islands. Rubiana.		Ellice group. Hudson Island.
		Maré.	Maré.	F.C.C. Kowiowi.	F.C.C. No. 2.	F.C.C. No. 3.	Dr. H.	E.U. A.M.	E.U. A.M. Head.	E.U. A.M. Head.	F.C.C.
	Age,	Adult.	10.	Aged.	Ad.	Ad.	Ad.	Ad.	...	...	Aged.
	Sex,	M.	F.?	M.	M.	M.	M.?	M.	...	...	F.
	Cubic capacity,	1556	1400	1425	...	...	...	1378	...	...	...
	Glabello-occipital length,	193	181	194	184	194	183	175	180*ap*	188*ap*	188
	Ophryo-occipital ,,	189	181	192	181	187	182	173	...	...	187
	Basi-bregmatic height,	139	133	138	138	...	136	142	...	...	141
	Vertical Index,	*72*	*73·5*	*71*	*75*	...	*74·3*	*81*	...	...	*75*
	Minimum frontal diameter,	93	92	102	98	100	100	100	...	...	100
	Stephanic ,,	105	106	108	114	124	110	114	...	...	116
	Asterionic ,,	112	105	110	...	...	108	114	...	...	115
	Greatest parietal breadth,	132*s*	126*p*	136*s*	132	152*s*	132*p*	132*s*	130	132	144*p*
	Cephalic Index,	*68·4*	*69·6*	*70*	*72*	*78*	*72*	*75·4*	*72*	*70*	*76·6*
	Horizontal circumference,	529	495	560	...	544	512	498	...	...	533
	Frontal longitudinal arc,	127	128	122	133	138	121	123	...	...	134
	Parietal ,, ,,	150	142	138	136	127	138	130	...	...	134
	Occipital ,, ,,	122	108	120	106	...	114	110	...	...	132
	Total ,, ,,	399	378	380	375	...	373	363	...	...	400
	Vertical transverse arc,	308	290	302	...	...	305	312	...	...	332
	Length of foramen magnum,	35	35	36	35	...	34	34	...	...	32
	Basi-nasal length,	103	94	110	104	...	104	108	...	...	104
	Basi-alveolar length,	106	96	106	...	...	103	116	...	...	...
	Gnathic Index,	*103*	*102*	*96ap*	...	...	*99*	*107*	...	...	...
	Interzygomatic breadth,	132	114	137	...	...	...	136	...	...	134
	Intermalar ,,	115	102	120	126	116	...	124	...	...	124
	Ophryo-alveolar length,	85	81	85	...	90	84	81	...	...	...
	Naso-alveolar ,,	66	58	65	...	65	66	65	...	...	...
	Facial Index,	*64*	*71*	*62*	...	...	...	*59*	...	...	...
	Nasal height,	49	45	53	...	48	47	47	...	...	50
	Nasal width,	24	22	28	28	24	25	25	...	...	...
	Nasal Index,	*49*	*49*	*53*	...	*50*	*53*	*53*	...	...	...
	Orbital width,	38	33	42	40	38	39	40	...	...	41
	Orbital height,	34	34	34	30	32	34	29	...	...	33
	Orbital Index,	*89*	*103*	*83*	*75*	*84*	*87*	*72·5*	...	...	*80*
	Palato-maxillary length,	59	51	59	...	...	59	64	...	...	50
	Palato-maxillary breadth,	63	59	...	67	60	63	67	...	...	64
	Palato-maxillary Index,	*107*	*115*	...	...	...	*107*	*108*	...	...	*128*
Lower Jaw.	Symphysial height	33	25	...	...	...	33	30	...	...	...
	Coronoid ,,	67	57	...	...	...	81	66	...	...	...
	Condyloid ,,	63	52	...	...	...	76	60	...	...	...
	Gonio-symphysial length,	101	87	...	...	...	89	101	...	...	...
	Intergonial width,	95	71	...	...	...	99	88	...	...	...
	Breadth of ascending ramus,	45	40	...	...	...	36	46	...	..	...

mangans are a kindred race to the Tannese; a Samoan colony had settled on the island Fatè. Up to this time two crania only, from Erromanga, the largest of the southern New Hebrides, have been described, both in the Barnard Davis collection. I have had the fortune to examine four additional specimens from that island, three in the Museum of the Free Church College, Edinburgh,[1] and one from the collection of the late Dr. Handyside, now in the Edinburgh University Anatomical Museum. Their measurements are given in Table XVII. Three of these crania were decidedly dolichocephalic, like those in the Barnard Davis collection, and in each specimen the vertical index exceeded the cephalic. The gnathic index was mesognathous, the nasal index mesorhine, the orbital index microseme. The male skull, Kowiowi, may be taken as typical of these dolichocephalic Erromangans. It was beyond the adult stage, as the sockets of the majority of the teeth were absorbed. It was very massive, for without the lower jaw it weighed 1 lb. 14½ oz. avoir. The glabella, supraciliary and occipital ridges were projecting, and the temporal ridges were double. The antero-posterior diameter of the temporal fossa was 132 mm., and its depth 96 mm. The vertex was roof-shaped. In this and the other Erromangans the frontal diameters were greater than in the Loyalty Islanders. The skull from the Handyside collection was the only one with a lower jaw; the chin was massive and projected forwards, the antero-posterior diameter of the ramus was much less than in the Loyalty Islanders, the coronoid was pointed and with a narrow base, the sigmoid notch was deep, and the gonio-symphysial length was much less than the intergonial width. This skull had also a remarkably long vaginal process ensheathing the styloid. The fourth skull, No. 3 in the Free Church College Museum, had a cephalic index 78, and approached therefore brachycephalic proportions. It belonged obviously to a different type from the others; it was not ridge-like on the summit but well filled, so that the cranial vault was relatively flattened, and the norma verticalis was rounded. The glabella was projecting. There was no evidence of artificial flattening either in the frontal or occipital regions.

Three crania from Tanna are in the Barnard Davis collection and one in the Museum of the Royal College of Surgeons. Their respective cephalic and vertical indices are C.I. 85, V.I. 83; 77, 85; 72, 72; 75, 75.[2] The Barnard Davis collection also contains a skull from Aneitum, C.I. 68, V.I. 73. The Museum of the Royal College of Surgeons has a skull from Ambrym, C.I. 70·2, V.I. 75·1; one from Cherry Island, C.I. 77·7,

[1] I am indebted to Prof. Duns, D.D., for the opportunity of studying these crania, as well as the one from Hudson Island, Ellice group, in the same museum, referred to on p. 103. One of the three Erromangan skulls is especially interesting. It is that of Kowiowi, the leading actor in clubbing to death the Rev. John Williams. Kowiowi was under chief at Bunker on Dillons Bay at the time of the murder in November 1839. Accompanying the skull was a letter to Dr. Duns from the donor stating how and by whom the skull was obtained. The Erromangan skull from Dr. Handyside's collection is also said to have belonged to one of the men who killed Williams. This skull has, however, some feminine characters, which make its sex doubtful. A slice had been taken out of the parietal bone as if with a tomahawk.

[2] For further measurements and indices see the Thesaurus Craniorum and Prof. Flower's Catalogue so often cited.

V.I. 86·9; two from Banks's Islands, C.I. 73·3, V.I. 73·3; C.I. 80, V.I. 78·8. In the same museum are two from Api, and in the Barnard Davis collection is one from the same island, the indices of which are C.I. 73·8, V.I. 73·3; C.I. 77·5, V.I. 81·1; C.I. 66, V.I. 76. Ten crania from Faté are in the Barnard Davis, College of Surgeons, and Paris Museums. MM. de Quatrefages and Hamy give the mean C.I. of five males as 68·4, the V.I. 73·6; the C.I. of one female 20·2, the V.I. 77·7. The Barnard Davis specimens are respectively C.I. 65, 69, 80; V.I. 75, 77, 77. Three skulls from Vanikoro have been carefully described, and one of them figured by Mr. G. Busk.[1] The cephalic indices are respectively 70·4, 71, 71, and the vertical indices 80, 84·4, 82·6. The height of these skulls is, as Mr. Busk points out, very remarkable. The gnathic index is not as a rule very pronounced. Mr. Busk also recognises the general preponderance in length of the parietal longitudinal arc over the frontal.

From the observations of MM. Quoy and Gaimard on the "Astrolabe"[2] and of those of M. P. A. Lesson, the people of Vanikoro are Papuans, though Lesson states[3] that they are more or less mixed with a yellow Polynesian race. A single skull from the island of Espiritu Santo is in the Godeffroy Museum. Krause gives the length 184 mm., breadth 138, height 139; the cephalic index is 75, the vertical index 75·5.

Much light has of late years been thrown on the skulls of the people of Mallicollo, one of the northern New Hebrides. The collection of eight crania in the Museum of the Royal College of Surgeons described by Mr. Busk,[4] the series of monumental heads and deformed skulls in the same museum described by Prof. Flower,[5] and the sixteen crania in the Godeffroy Museum of which Dr. Krause has given an account,[6] have supplied interesting material for study. The people of this island are distinctly Papuan in their external characters, but amongst them the practice of artificially deforming the head by pressure applied to the frontal region during infancy extensively prevails. This practice of course affects the measurements, but when allowance is made for the change in form produced by pressure, the skulls are without doubt dolichocephalic. In Mr. Busk's series the breadth index varied from 68 to 74, and four of the skulls were below 70. The height index in each skull was with one exception above the breadth index. The mean length of the skulls in the Godeffroy Museum was 181·8 mm., the maximum 195, the minimum 164; the mean breadth was 127 mm., maximum 135, minimum 122; the mean height was 138 mm., maximum 147, minimum 125. The mean indices were as follows—C.I. 69·8, V.I. 76. In the Anatomical Museum of the University of Edinburgh is a skull marked "Mallicollese," which was purchased many years ago from a sailor by the late Prof. Goodsir. It showed no flattening in the frontal region, but had been markedly flattened and rendered unsymmetrical behind by pressure in the parieto-occipital region. The

[1] *Journ. Anthrop. Inst.*, vol. vi. p. 200, 1877.
[2] Voyage de l'Astrolabe, Hist. vol. v.
[3] *Revue d'Anthropologie*, t. v. p. 257, 1876.
[4] *Journ. Anthrop. Inst.*, vol. vi. p. 200, 1877
[5] *Journ. Anthrop. Inst.*, vol. xi., 1881.
[6] *Op. cit.*, p. 616.

highest part of the skull was about midway between the bregma and obelion, and the height from the plane of the foramen magnum to the summit was 5·4 inches. The antero-posterior diameter of the temporal fossa was 117 mm., being materially below that of the Erromangans or Loyalty Islanders. The measurements are given in Table XVII.; C.I. 75·4, V.I. 81. Prognathism was very marked and the palato-maxillary region was one of the longest that I have measured. Traces of the frontal suture extended through the glabella into the ophryon. A large epipteric bone existed on each side; Wormian bones were in the lambdoidal suture, and a suture passed from the infraorbital foramen into the floor of the orbit. The antero-posterior and transverse diameters of the foramen magnum were equal. The lower jaw had a wide ramus, a broad-based coronoid process, and a shallow sigmoid notch. From Prof. Flower's description and figures it is evident that the artificial flattening of the head in the Mallicollese is not limited to the frontal region, but that in some cases pressure is applied to the back of the head. This is corroborated by the specimen I have now described.

The *Fiji Archipelago* forms the north-eastern group of islands of the Melanesian region. They are inhabited by a race possessing well-marked Papuan characters, but colonies of the brown Polynesians from Samoa and Tonga have established themselves in many of these islands, especially on the sea-coast.[1] The best collections of skulls from Fiji are in the Godeffroy Museum, which possesses seventy-four crania; the Museum of the Royal College of Surgeons, with twenty-four specimens; the Natural History Museum in Paris, with fifteen specimens; and the Barnard Davis collection, with ten specimens. Other museums also contain individual crania.

A skull of brachycephalic proportions, cephalic index 84·2, from the Fijian island Moutouata is in the Army Museum of the United States.[2] A few mesaticephalic crania from the islands Mango, Vanua Balavu, Vakaia, Moturiki, Kandavu, Dzizia, and Ovalau, varying in their cephalic indices from 75·1 to 79·2, have been recorded by Barnard Davis, Flower, Krause, de Quatrefages with Hamy and Rabl-Rückhard; but skulls of these proportions are quite exceptional. The great majority of the Fijian skulls which have been measured are dolichocephalic, and as a rule so long and narrow that the term stenocephalic has been applied to them. A most careful description, with figures, of a series of sixteen crania of the Kai Colos, or natives of the mountains of the interior of Viti-Levu, has been given by Prof. Flower.[3] The breadth index was in each skull below 70, and the height index in each specimen was markedly above that of the breadth. Dr. Krause gives the following numbers as the mean measures of the skulls in the Godeffroy Museum obtained from the following islands:—Viti-Levu, C.I. 67·6, V.I. 75·1; Moturiki, C.I. 68·8, V.I. 75·2; Ovalau, C.I. 69·1, V.I. 76·1. The people of Mango

[1] Die Inseln des stillen Oceans, by Prof. Meinicke; also Wallace's Australasia.

[2] Referred to by de Quatrefages and Hamy, p. 291.

[3] Cranial Characters of Natives of Fiji Islands, *Journ. Anthrop. Inst.*, vol. x., November 1880.

have a mean C.I. 73·2, V.I. 77·3; those of Oneata, C.I. 74·6, V.I. 78·8, so that, as both Flower and Krause have pointed out, the dolichocephaly diminishes in the eastern islands, *i.e.*, in those in closer proximity to the Tonga Archipelago, and a transition is established between the stenocephalic western Fijians and the brachycephalic Tongans, due without doubt to an intermixture of the two races.

From the observations of the several craniographers to whose labours I have had so frequently to refer in the course of this comparison, the conclusion has been drawn that the skulls of the Melanesians are distinctly dolichocephalic, and this conclusion has been confirmed by the additional observations recorded in this Report. But further, it has been shown that the height of the Melanesian skull exceeds its breadth, so that the vertical index is greater than the cephalic. The presence of a people in some of the islands in the Melanesian area in whom the skull is remarkably long, narrow, and high, was especially pointed out by Dr. Barnard Davis, and the skulls of this form were named by him hypsistenocephalic.[1] He describes the people of New Caledonia, the New Hebrides, the Loyalty Islands, probably the Fijians, and perhaps some of the Caroline Islanders, as possessing skulls of this form. The correspondence of the crania of the people of Vanikoro with this type was pointed out by Mr. Busk. Prof. Flower states that the skulls of the Kai Colos, or mountaineers of Fiji, belong to the most pronounced hypsistenocephalic type, and the skulls of the Loyalty Islanders described in this Report are characteristic examples.

Although both the Admiralty Islanders and the dolichocephalic people of New Guinea agree with the people named in the last paragraph in having a vertical index greater than the cephalic, yet, if one place side by side the Loyalty Islander skulls, the drawings of the Fiji mountaineers published by Prof. Flower, the New Guinea skulls from Jarvis Island, Tomara, and Possession Bay (Table XVI.), and the Admiralty Islander crania, the Fijians and Loyalty Islanders can be at once distinguished from the New Guinea and Admiralty Islanders. The Fijians, Loyalty Islanders, and New Hebrideans have larger and more massive crania than the others, and belong evidently to a people physically stronger. But the differences in the two groups can be more definitely brought out by comparing my measurements of the Admiralty Islanders with those of the Fijian mountaineers made in an almost similar manner by Prof. Flower.

The Fijian skulls are remarkably dolichocephalic, for the mean cephalic index of eleven specimens (six males, five females) is only 66, whilst that of the Admiralty Islanders is 70. This low latitudinal index, whilst showing a material difference in the relations of length and breadth in the two series of crania, yet does not express all their differential characters in these dimensions. For whilst in none of the Admiralty Islanders does the glabello-occipital diameter exceed 186 mm., and in five specimens falls below 180, in the

[1] Peculiar Crania of Inhabitants of certain groups of islands in the Western Pacific, *Natuurk. Verhand. Holland. Maats. Wetensch.*, Haarlem, vol. xxiv., 1866. See also *Anthropological Review*, vol. iv. p. 48.

shortest of the Fijian skulls (two females) it is 182, whilst six specimens (all males) are 190 or upwards. In their greatest transverse diameters the two series of skulls much more closely approximate, for whilst the average of the twelve Admiralty Islanders is 128 mm., that of the eleven Fijians is 126. The Fijian skulls are therefore not only relatively but absolutely considerably longer than the Admiralty Islanders. The crania also exhibit differences in the altitudinal or vertical index, for whilst the average height of the Admiralty Islanders is 131 mm., that of the Fijians is 140. In consequence, therefore, of this predominance in length and height, the Fijian skulls possess a considerably greater cubic capacity, the average of which in the males is 1504 c.c., in the female 1327 c.c., so that their female average is somewhat higher than that of the males and females collectively in the Admiralty Island series.

All the Fijian skulls are strongly phænozygous. In the Admiralty Islanders, notwithstanding the broken zygomatic arches in several specimens, the skulls are as a rule manifestly cryptozygous. In the degree of prognathism the two series of crania closely correspond, for the average gnathic index in the Admiralty Islanders is 103, and that of the Fijians is 103·7. A marked difference, however, is to be seen in the relations of the length and breadth of the nasal aperture, for whilst the breadth is more than half the height in the Fijians, in whom the average nasal index is 56·6, and all the specimens, with one exception, belonged to the platyrhine group, only four of the Admiralty Islanders are platyrhine, six are leptorhine, and the general average is on the line between the leptorhine and mesorhine groups. The mean orbital index in the Admiralty Islanders is about the middle of the mesoseme series, and alike in the two sexes; whilst in the Fijians it shows a marked difference in the males and females. For in the males it is on the average 84·2, or barely within the mesoseme series, whilst in the females it is 90·7, or distinctly megaseme. In the form of the palato-maxillary region the two series of skulls are much alike, for the mean palato-maxillary index in the Admiralty Islanders is 112, and in the Fijians it is 111, so that they are both mesuranic.

In conclusion, whilst both series are markedly dolichocephalic, the latitudinal index is much lower, the altitudinal index is much higher, and the cranial capacity is greater in the Fijians than in the Admiralty Islanders; the Fijians are phænozygous, platyrhine, mesoseme in the males and megaseme in the females; the Admiralty Islanders are, as a rule, cryptozygous, lepto-mesorhine, and mesoseme. The two series of crania, however, closely correspond in the degree of prognathism and in the form of the palato-maxillary region.

The question therefore arises, are the people with hypsistenocephalic crania to be regarded as a different race from the other dolichocephalic people inhabiting the Melanesian region? Dr. Barnard Davis is evidently inclined to the opinion that they are a different race, but this opinion is not shared by ethnologists generally. Neither does the evidence which has been advanced in its support seem to me to be conclusive. For, as Dr. Davis himself admits, crania in which hypsistenocephalism exists do not all exhibit

it in the same degree. Crania pass by almost insensible gradations from the extreme form seen in Fiji or the Loyalty Islands to skulls which are of the New Guinea or Admiralty Island conformation. The hypsistenocephalic character seems to be an exaggeration of the Melanesian type, fostered perhaps by tribal interbreeding and hereditary descent amongst those who inhabit the mountainous regions, and those who have had little communication with the people of adjacent islands; whilst in the inhabitants of the sea-coast, more liable to intermixture, the type form has not assumed such exaggerated proportions, or perhaps has become altered by mingling with other races.

We may now pass to the consideration of the area occupied by the Mahori or brown Polynesian race. Ethnologists generally look to the Samoan and Tonga Islands as the central home of this race in the Pacific, from which it has diffused itself in several directions.[1]

The *Tonga Islanders*, so far as their skulls have been examined, are almost purely brachycephalic. Three adults measured by Prof. Flower are distinctly so, and six adults in the Godeffroy Museum, measured by Dr. Krause, are wholly so, with one exception, and that is mesaticephalic. The mean of the eight brachycephali is 84·5, and the range is from 80 to 89·4. Some children's skulls from the Tonga Islands have a cephalic index of 90·6 and 92·9. Krause states that the skulls of the Tonga Islanders have a high, steep, broad forehead, flat and deeply descending occiput, parietal tubera laterally projecting, broad face, large eyes and little prognathism.

The *Samoan Islanders* are not so uniformly brachycephalic. Two crania in the Museum of the Royal College of Surgeons are undoubtedly so, C.I. 80·6 and 89; but only three out of thirteen skulls, mostly from Upolu, in the Godeffroy Museum have a cephalic index above 80; four are below 75, whilst six are mesaticephalic; but of those, five are above 77, so that they approach the brachycephalic standard. It would look therefore as if a certain Melanesian admixture with the Polynesian people had taken place in Upolu. The vertical index in the Samoan dolichocephali was as in the Melanesian race distinctly higher than the cephalic. Whereas in the brachycephali the vertical index, though occasionally above the cephalic, as a rule was not so, and in some instances was markedly below it. Krause gives the cephalic index of a skull from the small island Futuna as 87, and Flower that of a native of Savage Island(Niuë), lying midway between the Tonga and Samoan groups, as 83·8. The Rev. G. Turner states that Savage Island is populated by light copper coloured natives very like the Samoans, and that their dialect is a mixture of Samoan and Tongan; but Mr. W. L. Ranken, although recognising their Samoan affinities, considers that there is also an intermixture of Papuan traits.

Crania of the *Ellice Islanders*, to the north-west of the Samoan Islands, are very

[1] See the accounts of the Samoans by the Rev. S. Whitmee (*Contemporary Review*, February 1873); Mr. Pritchard and Mr. W. L. Ranken in *Journ. Anthrop. Inst.*, vol. vi. p. 224, and Rev. G. Turner in "Samoa," London, 1884.

sparingly represented in our museums. Prof. Flower gives the cephalic indices of two specimens from Nanumea as 81·2 and 77·5, and their vertical indices 76·8 and 75·3. Dr. Krause has measured one from Niutao, with C.I. 83·2, and V.I. 76·5. In Table XVII. I have given the measurements of a skull in the Museum of the Free Church College from Hudson's Island in the Ellice group. This skull was apparently that of a woman well advanced in years, for the sutures of the cranial vault were almost obliterated. The cephalic index was 76·6 and the vertical index was only 75. In its configuration this skull closely resembled the mesaticephalic Erromangan described on p. 97, and like it was probably a cross between a Melanesian and a Maori. The breadth of the palate greatly preponderated over the length, so that the palato-maxillary index was unusually high. The Rev. G. Turner says,[1] that tradition traces the origin of the people of Hudson's and the other islands of the Ellice group to Samoa.

Hervey's or Cook's Islands have apparently contributed only two skulls to museums. The one from Mungaia in the Barnard Davis collection is distinctly dolichocephalic, and has C.I. 70, V.I. 76; the other from Rarotonga, in the Godeffroy Museum, has very different proportions, and is very brachycephalic, C.I. 86·4, V.I. 79; Krause also states that it is strongly prognathic. This difference in the cranial proportions is in accordance with what has been said as to the physical characters of the people of these two islands. For Rarotonga "is inhabited by people who have legends of their migration from Samoa and speak a closely allied language;" whilst in Mungaia the "Melanesian type predominates, the people being dark brown, with wavy or frizzled hair and well bearded."[2]

The *Society Islands* are represented by at least thirty crania, twenty-three of which are in the Natural History Museum, Paris, and the remainder in the Godeffroy Museum, the Barnard Davis collection, the "Novara" collection and the Museum of the Royal College of Surgeons. The mean cephalic index of these series of skulls is 77; the maximum being 79·6, a skull from Tahiti; and the minimum 74, a skull from Raiatea. The vertical index in these specimens is as a rule higher than the cephalic. Tradition points to these islands as having been settled from Samoa.

The *Low or Paumotu Archipelago*, to the immediate south-east of the Society Islands, has contributed a number of crania, the majority of which are in the Paris Museum. MM. de Quatrefages and Hamy state that these islanders have crania which are generally like those of the Society Islanders, but they do not record any measurements. Dr. Krause gives the measurements of two specimens from Tipoto and Niau in the Godeffroy Museum, the cephalic index of one is 76, that of the other 76·3. Another specimen from Bligh Island is described by Zuckerkandl,[3] who places the breadth index at 70·8. He says that the specimen is stenocephalic, and differs from the skulls of other Polynesians

[1] Samoa, pp. 288, 293, London, 1884.
[2] W. L. Ranken in *Journ. Anthrop. Inst.*, vol. vi., 1877, and Wallace, Australasia, p. 507.
[3] Reise der Novara, Anthropologischer Theil, p. 111, 1875.

to which he has had access. The skull of a Gambier Islander, one of the southern islands of this archipelago, in the Barnard Davis collection, has a cephalic index 72 and a vertical index 79. Mr. Ranken states that the natives in the Paumotus show some evidence of a people having been there prior to the Mahori occupation, and that they have a number of words not traceable to any Mahori dialect.

Crania of the *Marquesas Islanders* are abundant in the Barnard Davis collection and in the Paris Museum, the Godeffroy Museum also contains four examples. Of the thirty-six specimens in the Barnard Davis collection fourteen had a cephalic index of 80 or upwards, fifteen were from 75 to 80, and seven were below 75. In the brachycephali the vertical index was as a rule below the cephalic, in the dolichocephali it was as a rule above it, whilst in the mesaticephali it was sometimes above, at others below. Of the four specimens in the Godeffroy Museum, one was brachycephalic and three were mesaticephalic. MM. de Quatrefages and Hamy do not give the measurements of the individual crania in the Paris Museum, but they place the mean of twelve crania of the Teïs from the environs of Fort Collet at 79·4, whilst eight crania from Tahou-Ata have a mean cephalic index of 75·3. It is obvious therefore that a considerable diversity exists in the cranial proportions of the natives of this group as well as in the separate islands. Thus the skulls from Nuka-hiva in the Barnard Davis collection varied in the cephalic index from 69 to 83; those from Fatu-hiva varied from 70 to 86; those from Ohivaoa from 74 to 84; and those from Uahuga from 76 to 82. The series from each of these islands, therefore, excepting the last, contained skulls possessing dolichocephalic, mesaticephalic, and brachycephalic proportions. Two crania from Nuka-hiva were also collected by the "Novara";[1] the one had a cephalic index 73·5, the other 79·5.[2] Tradition points to the colonisation of these islands from the Samoan group.

The *Sandwich Islanders* present great diversities in the proportions of the crania, as I have already pointed out in a previous section of this Report (p. 62, *et seq.*), so that the thirty-six adult crania varied in the cephalic index from 71 to 86; and of these ten were upwards of 80, eleven were from 75 to 79 both inclusive, and fifteen were below 75. As it happened the four skulls from Hawaii were all brachycephalic, but the thirty-two from Oahu presented examples of each of the three divisions of the length-breadth index.[3] My measurements of the skulls from Oahu are generally in accordance with those made by Dr. Barnard Davis on a still larger collection from that island presented to him by W. L. Green, Esq. A reference to the measures recorded in the Thesaurus Craniorum will show that his collection of upwards of one hundred skulls varied in the cephalic index from 69

[1] See Zuckerkandl's description, and pls. xvi., xvii., and xx.

[2] Blumenbach has also figured a Marquesan cranium. Plate L. Decas quinta.

[3] A description of the burying ground at Waimanalo, Oahu, from which Mr. Moseley obtained the skulls described in this Report (p. 62), has also been given by Dr. Finsch, *Zeitschr. für Ethnol.*, Bd. xi. p. 326, 1879. Dr. Finsch considers that the skeletons found there are pure Hawaians, belonging to a period free from European influence, as this part of the coast has not been disturbed by white people.

to 90. Sixty specimens had a cephalic index of 80 or upwards; twelve were below 75, and the remainder were from 75 to 79 both inclusive; the brachycephali were, however, present in a larger proportion than in my series from the same island. Six skulls from Hawaii in the same collection varied in the cephalic index from 72 to 86, and of these, four were 81 or upwards. Dr. Davis gives the mean C.I. of the entire series of Sandwich Islanders in his collection as 79 for the men and 80 for the women. Of the four skulls from Hawaii in the Museum of the College of Surgeons, two had the cephalic index 81·7, 85·7; the other two were 69·5 and 71·8. MM. de Quatrefages and Hamy give the mean cephalic index of fifteen male Sandwich Islanders as 75·5 and of seven females as 78·4. They also refer to a large collection from the islands Maui and Kauai measured by M. Otis, the mean breadth index of ninety-seven men being 81·3, and of forty-one women being 80·5. As the measurements of the individual skulls are not given by these last named craniologists, I am not able to say what is the range of variation in their respective series. It is well known that the practice of artificially flattening the back of the head prevailed to some extent amongst the Sandwich Islanders, and I agree with MM. de Quatrefages and Hamy that this will necessarily have the effect of somewhat raising the cephalic index of the skulls in which this deformation exists. In my series of skulls the relation of the vertical to the cephalic index varied with the cephalic index. In the brachycephali and almost all the mesaticephali the vertical index was less than the cephalic, whilst in a considerable number of the dolichocephali the vertical index exceeded the cephalic. The former therefore corresponded in this relation with the Polynesian, the latter with the Melanesian character.

Retzius, from the study of a Sandwich Island skull in his collection, and of a number of Polynesian skulls which he saw in London, came to the conclusion that they were one of the highest members of his brachycephalic prognathic class, and formed a transition from this to the dolichocephalic.[1] Dr. Uhde has also described four crania from Oahu,[2] three of which came from a battlefield on the plain of Kulau, and one from the neighbourhood of Diamonds-hill on the south-east coast. He recognises such differences between them as to place two in Retzius's *dolichocephalæ prognathæ* and two in his *brachycephalæ prognathæ*.

There is thus abundant evidence to show that the crania of the Sandwich Islanders are by no means homogeneous in their characters, but present wide differences in form and proportions, and in this respect they agree with the Marquesas Islanders. To what are these differences to be ascribed? The most rational conclusion I think will be that they express the presence in these islands of more than one race of men. Captain Cook refers to the fine physique of the chiefs and their superiority to the natives generally.

[1] Ethnologische Schriften, p. 65; and *Müller's Archiv, Anat. u. Physiol.* 1874.

[2] *Nova Acta Acad. Nat. Cur.*, vol. xxviii., 1861.

M. Choris also speaks[1] of these differences between the chiefs and the common people, and further points out that in some the hair is crisp or frizzled, approaching to a woolly appearance, in others it is soft and flexible; the skin also differs in colour from yellow to a rich brown. Dr. Bielitz, quoted by Uhde, also states that the chiefs of the Sandwich Islands differ remarkably in size, strength, colour, &c., from the common men, which led him to conclude that two different races existed there. There is thus a concurrence of opinion amongst travellers of such differences in the external characters of the people as would point to the presence of both a Polynesian and a Melanesian element, and these differences are supported by their craniology. Where but little intermarriage had taken place between the two races, each would preserve its purity of type, but with an intermixture then the two races would be more or less fused with each other. The traditions of the Sandwich Islanders point to Tahiti the largest of the Society Islands as the place from which they came, and it is not unlikely that these Polynesian adventurers when they landed on Oahu and the other Sandwich Islands found a Melanesian people living there.

New Zealand, with its outlying dependency the *Chatham Islands*, has been generally regarded as inhabited by the Polynesian race. Owing to the English colonization numerous crania have been collected, more especially from New Zealand, and are now in museums.

The measurements of fourteen skulls from the Chatham Islands in the Barnard Davis, College of Surgeons, Godeffroy, and Paris Museums, and in the collection formed by the "Novara," have been published, and to these may now be added the nine skulls described in this Report. The cephalic index varied greatly in this series of twenty-three skulls. If I exclude the child's skull, measured by Barnard Davis with an index of 89, the crania varied from 72 to 83, and presented examples of dolichocephalic, mesaticephalic, and brachycephalic crania; two were 80 or upwards, four were below 75, and sixteen were from 75 to 79 both inclusive, the preponderance therefore being decidedly in favour of those with intermediate proportions. The mean cephalic index of the series was 76. In the few skulls with a high cephalic index the height was less than the breadth, but it is also to be noticed that even in the skulls with a low breadth index, the vertical index was as a rule below the cephalic. The crania also were not prognathic, and although the average of Prof. Flower's series of five skulls was somewhat above mine, yet his are only mesognathous. De Quatrefages and Hamy refer to the cubic capacity of the crania of the Chatham Islander men as being exceptionally large, but this was not the case in my specimens, in which the mean of the series was the same as that of the New Zealanders.

The New Zealand crania are much more numerous in museums than the Chatham Islanders. In addition to the twenty-one specimens described in this Report, the Barnard

[1] Quoted by Prichard in *Natural History of Man*, vol. ii., p. 440.

Davis collection contains nine specimens, the Museum of the College of Surgeons at least thirty, the Natural History Museum in Paris possesses upwards of thirty skulls, the Godeffroy Museum three; eight are described in the account of the "Novara" Expedition,[1] whilst individual specimens are in the Berlin and other museums. MM. de Quatrefages and Hamy do not give the measurements of the individual skulls in the Paris Museum, but only the average; they place the cephalic index of fifteen men at 73·26, that of fifteen women at 72. More detailed measurements of seventy-two specimens are, however, given by Barnard Davis, Flower, Zuckerkandl, Krause, Rabl-Rückhard, and myself, from which I gather that only five specimens had a cephalic index of 80 or upwards; forty-one were below 75, and twenty-six between 75 and 79 both inclusive. The mean breadth index of the entire series was 74. The New Zealanders therefore incline to dolichocephalism, and at least four are recorded with a breadth index below 70.[2] Not unfrequently in the skulls with the lower cephalic index the vertical index exceeded the cephalic, but there were so many exceptions that it cannot be regarded as the rule in them for the basi-bregmatic height to exceed the greatest breadth. The crania are not characterised by any marked projection of the upper jaw. The mean of my series, as already stated, was orthognathic, the mean of Prof. Flower's measurements places his series of skulls on the verge between orthognathism and mesognathism.

The traditions of the New Zealanders, the study of their language by several philologists,[3] and the observations on their external characters by Captain Cook and other voyagers have all combined to the conclusion that the Maoris are an offset of the great Polynesian race, and their traditions point to Samoa as the group of islands from which they had sprung. If this view of their origin be correct, then we should expect that their cranial characters would correspond with those of the people from whom they had originated. It is of course impossible to state with any precision at what date they had separated from their parent stock and settled in New Zealand, but this must have happened a number of centuries ago. We have already seen that the Polynesians living in the islands nearer to the equator, although they possess a large percentage of brachycephalic heads, yet have intermingled with them skulls of mesaticephalic and dolichocephalic proportions. To some extent this is doubtless in part due to comparatively recent intermixtures of the Melanesian and Polynesian races. But if, as I shall attempt to show immediately (p. 110), a Melanesian people had inhabited Polynesia prior to its colonisation by the yellow brown race, and had to some extent fused with it, then the New Zealand colonists would not have been pure Polynesians, but would have had a

[1] Zuckerkandl, *op. cit.*

[2] The remarkably elongated skull in the Museum of the College of Surgeons, with an index of only 62·9, described by Prof. Huxley in his paper on two widely contrasted skulls (*Journ. Anat. and Phys.*, vol. i. p. 60, 1867), and which he thought might be a New Zealander, is now regarded by Prof. Flower (New Cat., p. 216) as more probably from the New Hebrides. It is not included in the above summary.

[3] *The Transactions of the New Zealand Institute* contain many valuable and instructive papers on the origin of the Maoris.

certain admixture of Melanesian blood. But, on the hypothesis of a general diffusion of the Melanesian stock over the Pacific Islands, it is possible that New Zealand may have been inhabited by people of that stock prior to the Polynesian invasion, and in consequence a still further dilution of the Polynesian characters, either in particular localities or pretty generally throughout the island, may have taken place by interbreeding between the two races.

In support of this hypothesis I may refer to the accounts which have been given of the external appearance of the Maoris, from which it is clear that considerable differences have been observed in their hair and features. The skin varies in colour from a clear olive brown to an opaque black-brown. The hair is brown, or black, or even reddish, and straight or curly; the beard is often well-grown and bushy.[1] The features are sometimes coarse, with thick lips and broad noses, at others much more delicately moulded. Their crania also exhibited many variations from the Polynesian type. As already stated (p. 107), but a small percentage were brachycephalic, whilst a large proportion were dolichocephalic, and the mean cephalic index of the series of seventy-two skulls was 74, which places them just below the mesaticephalic minimum. It is clear therefore that there is a strong tendency in the skulls of this people to assume dolichocephalic proportions, and thus to depart from a pure Polynesian type, much more strongly than is the case with the Samoans, the Marquesas Islanders, or even the Sandwich Islanders. It would be interesting to inquire whether marked differences exist in the form of the skull in different districts, and whether there are equally marked variations in skulls from the same district. Unfortunately the collection on which I have reported does not enable me to go very completely into such an inquiry, but I may point out that the six crania from Kapiti Island, all apparently from one tribe, varied in the cephalic index from 67 to 78 amongst the adults, and in a child rose to 82, whilst the vertical index varied from 69 to 76, and that considerable differences existed in the nasal, orbital, and palato-maxillary indices.[2] The skulls from near Auckland also varied in their cephalic index, so that it would seem as though considerable differences in this respect may occur in people of one and the same tribe.[3] The conclusion therefore to which I have come from the consideration of these

[1] In the Anatomical Museum of the University of Edinburgh are four tattooed and preserved heads of New Zealanders. In one the hair was jet black, long, closely set, thick and wavy. This man also had a short-clipped thin moustache and a moderate beard, the hairs of both of which were brown and brownish-black. In the second the hair was long, black and straight. He had a short thin brown moustache and a tuft of hair at the chin. In a third the hair was reddish-brown and straight, long at the back and short at the front of the head. In the fourth the hair was brown-black, and arranged in spiral tufts, the hairs of which, when straightened out, were five or six inches long. These tufts were separated from each other by intermediate portions of scalp, from which the hair had been cut quite close to the skin. The tufts were therefore isolated from each other by the cutting away of the intermediate patches of hair.

[2] MM. de Quatrefages and Hamy give the mean measurements of two adult male crania from Kapiti, which yield the following indices:—Cephalic index, 76·3; vertical index, 75·1.

[3] In the description of the New Zealand crania in the earlier part of the Report (p. 77), I have omitted to state that in the skull from Marlborough the temporal ridge mounted in a remarkable manner to near the vertex, so that on the left side its summit was only 20 mm., and on the right side 22 mm. from the sagittal suture.

various facts is that the study of the crania supports the view that New Zealand had been occupied by a dolichocephalic and probably Melanesian race, before the Polynesian element was introduced into it.

The origin of the Chatham Islanders is shrouded in mystery. The massacre of so large a portion of these islanders by the Maoris before Europeans had become well acquainted with them, has interfered with our obtaining much information on their traditions. It is believed, however, that the Morioris are the result of an intermixture of Polynesians with Melanesians. It is said that they are shorter and stouter than the Maoris, darker in the skin, with lank black hair, aquiline noses, and a Jewish cast of countenance,[1] and that they can be readily distinguished from the Maoris. From the description of their crania in the earlier part of this Report (p. 73), it will be seen that they are in the lower term of the mesaticephalic series, and that the vertical index is less than the cephalic. Their breadth index was somewhat higher than the New Zealanders, and their nasal index was somewhat lower, but in other respects the proportions of parts in the two series of crania closely corresponded. The slope downwards and outwards from the sagittal suture to the parietal eminences, and the vertical direction of the wall of the skull below the parietal eminence, gave to the New Zealand skull, though in a less degree, that pentagonal outline in the norma occipitalis which has already been referred to (p. 73) as so marked in the Chatham Islanders. The characters of the skulls of the Morioris are such as might well be referred to a mixture of the Polynesian with the Melanesian race, and it is possible that, as in New Zealand itself, the Polynesian settlers may have found this group of islands occupied by a Melanesian people, and have intermingled with them.

From this summary of the proportions of the skulls of the people occupying the Polynesian area, it would appear that there is great diversity in the relation of the length to the breadth of the cranium, so that brachycephalic, mesaticephalic, and dolichocephalic crania are found amongst them. In some localities in the Melanesian area, more especially in and near New Guinea, a similar diversity was described, though the dolichocephalic type predominated, and in such localities as the mountains of Fiji and the Admiralty Islands seemed to be the exclusive form. These modifications in the relation of length to breadth in the Melanesian area were ascribed to a mixture of other races with the prevailing Papuan stock, and the question now arises whether a mixture of some other race or races with the proper Polynesian stock has taken place so as to have caused a modification in the form of their head.

If we assume that the type form of the skull in the Polynesians is brachycephalic, then, so far as our present material for observation admits of conclusions to be drawn, we may say that the Tonga Islanders present this type in its purest form. But if we pass from these islands to the groups situated either north, south, east, or west, then along

[1] Mr. E. A. Welch's account of these people in *Anthropological Review*, vol. viii. p. ci., 1870.

with brachycephalic crania others are intermingled which have mesaticephalic and even dolichocephalic proportions. From what quarter then has the race proceeded which has given this more pronounced length to the skull? There can, I think, be little doubt that this is due to a mixture with a Melanesian element. What the relation may be as regards time when the Polynesians and Melanesians first colonised their respective islands, which in short is the older race, is of course very difficult to say, though I am inclined to think that the Melanesians have the greater antiquity. Various considerations might be advanced in support of this position. The proficiency of the Polynesians in agriculture, in native manufactures, in the art of carving, their songs and traditions, their treatment of women, their submission to the government of chiefs, and their religious observances, all point to the Polynesians as having reached a stage of civilization which places them in advance of the pure Papuans. But the fact that dolichocephalic heads are much more generally diffused throughout the Polynesian area, than are brachycephalic heads throughout the Melanesian area, points to the conclusion that the Pacific Islands generally were at some remote period inhabited by a dolichocephalic and probably Papuan race, which in several islands has been entirely replaced by the Polynesians, in others very much intermingled with them,—so that the present inhabitants are a mixed race,—whilst in others again it has retained its pristine purity. How extensive this diffusion has been is shown by the considerable proportion of dolichocephalic crania which have been procured from islands so far removed from each other as the Sandwich Islands in the North and New Zealand in the South Pacific. The people of Humphrey's Island in the Manaluki group, about 700 miles west of the Marquesas Islands, are said by the Rev. George Turner to be light brown eastern Polynesians, but the inhabitants of Penrhyn's Island, in the same archipelago, have been described by Mr W. L. Ranken[1] as tall, dark brown, with wavy hair sometimes frizzled into mops, and with prominent noses, all which characters are Papuan. Penrhyn's Island has been regarded as the most easterly home of the Melanesians. Although we know but little of the craniology of the remote and solitary *Easter Island*, and although the inhabitants are said to be Polynesians from Rarotonga,[2] yet the only skull from this island, so far as I know, in any collection, viz., that in the Museum of the College of Surgeons, has, according to Prof. Flower, a breadth index 69·1 and a height index 72·9. In both these particulars its characters are Melanesian and not Polynesian. The study of the crania in the Polynesian area has led me therefore to a conclusion similar to that arrived at by Mr W. L. Ranken from a consideration of other data, viz., that the South Sea Islands had been inhabited by Papuans prior to the Mahori colonisation.

The *Gilbert Islanders*, again, in the Micronesian area have apparently a large admixture of Melanesian blood. Of the twenty-two skulls in the Godeffroy Museum,

[1] *Journ. Anthrop. Inst.*, vol. vi. p. 231, 1877.

[2] Meinicke, Die Inseln des stillen Oceans, Zweiter Theil, p. 229.

principally from the islands Majuro and Apamama, measured by Krause, nine had a cephalic index below 75, and the remainder ranged from 75 to 79·5, and of these only six were above 77. In the sixteen skulls, the cephalic index of which was below 77, the vertical index exceeded the cephalic. In three of the crania above 77 the vertical index was less than the cephalic, and in two they were almost equal to each other. Three skulls in the Museum of the College of Surgeons measured by Flower had the cephalic index ranging from 73·1 to 76·5; the vertical index in one specimen was less, in another equal to, in a third greater than the cephalic. Five male crania in the Paris Museum are said by de Quatrefages and Hamy to have a mean cephalic index 73·4 and a mean vertical index 77·3; two female crania a mean cephalic index 75·8 and a mean vertical index 79·4. A large proportion of the Gilbert Island crania which have been examined possess therefore the hypsistenocephalic character of the Melanesian skull. Krause states that prognathism was prominent in only six crania. The study of the skulls of the Gilbert Islanders had convinced him that in them the presence of another type than that of a purely Papuan race could be recognised. The mixed racial characters of the people of these islands has also been referred to by Prof. Meinicke and Mr. A. R. Wallace. The people of Peru Island, one of this group, according to the Rev. G. Turner, state that their ancestors came from Samoa, and both persons and places have Samoan names.

The *Marshall Islanders*, to the immediate north of the Gilbert Islands, have contributed but few skulls to museums. Two are in the Godeffroy collection, the one with a cephalic index 75 and a vertical index 79·3, the other with a cephalic index 77·4 and a vertical index 80·3. What little we do know of their crania points therefore to a mixture probably of the Polynesian with the Melanesian type. Krause states that these skulls approach closer to the Caroline than to the Gilbert Islanders.

The *Caroline Islanders* are much more extensively represented in museums. Prof. van der Hoeven described in 1865 a collection of nine skulls, seven men and two women, believed to be natives of Oolea, one of these islands,[1] and an excellent abstract of his memoir was published by the late Dr. Barnard Davis.[2] The mean length of these crania was 182 mm., their mean breadth 126 mm., their mean height 142 mm.; the mean cephalic index is therefore 69·2, the mean vertical index 78. These skulls are long, narrow, and high; they are hypsistenocephalic, and all possess this character. The Godeffroy Museum possesses forty-six skulls from this group, including one from the Pelew Islands. Eight skulls from Ponapé and Nemma were (with one exception C.I. 76) distinctly

[1] Beschrijving van Schedels van Inboorlingen der Carolina-Eilanden, Amsterdam, 1865.

[2] *Anthropological Review*, vol. iv. p. 47, 1866. Mr W. P. Pritchard comments in the same vol., p. 165, on Dr Davis's memoir, and furnishes interesting information on the spiral tufts in the hair of the people of Oceania. He doubts whether the hair grows naturally in these tufts, with bare spaces between, and considers that the tufts are directly the result of an artificial process, and that both they and the "mop-head" can be and are produced both by the frizzly-haired Melanesians and straight-haired Polynesians. See on this point my observations on the hair of a New Zealand head in note on p. 108.

dolichocephalic; the mean cephalic index was 72·2, and the mean vertical index 75·8. Sixteen skulls from the Mortlock Islands had a mean C.I. 74 and a mean V.I. 79. Eighteen skulls from Ruk had a mean C.I. 75·5 and V.I. 77·4. Three skulls from Yap had a mean C.I. 78·5 and V.I. 79·1, whilst the only Pelew Island skull had C.I. 83·8 and V.I. 85·6. Thus, as Dr. Krause has pointed out, the form of the skull in the Caroline Archipelago changes materially from east to west. In the easternmost islands the crania are dolichocephalic of the Melanesian type, whilst the skull from the western Pelew is brachycephalic, and those from Yap are in the higher term of the mesaticephalic. In passing from east to west therefore the cephalic index gradually rises. The western islanders have come under the influence of a brachycephalic race, which is apparently not Polynesian but Malay or Negrito, and this accords with the observations of several travellers. But further, I may state that the crania with a low cephalic index had the vertical index relatively much higher, whilst in the mesaticephali they closely approached each other, and in the only brachycephalic skull, the vertical exceeded the cephalic index.

Crania from the small *Hermit*, *Anchorites*, and *Echiquier Islands*, which lie to the south of the Caroline Islands, and to the immediate west of the Admiralty Islands, are in the Godeffroy Museum. The only skull from Hermit has a breadth index 80·4 and a height index 73·6.[1] The skull from the Anchorites has a breadth index 79 and a height index 73·3. Two other skulls from the Anchorites in the Berlin Museum have been measured by Dr Rabl-Rückhard; the one had a breadth index 78·5, the other a breadth index 77·9 and a height index 78·9. The two Godeffroy skulls from the Echiquier Islands have the cephalic index respectively 74·1 and 78·6, and the vertical index 77·4, 80·5. Another skull from the Echiquier Archipelago is referred to by de Quatrefages and Hamy (p. 204), as having been described by MM. Incoronato and Tocco. Its antero-posterior maximum was 166 mm., its transverse maximum 135 mm., and its cephalic index 81·3. These crania are of course too few on which to base a generalisation, but they point to a considerable mixture of a brachycephalic race with the Melanesian element, which, from the proximity of these small islands to New Guinea, the Admiralty Islands, and New Britain, one would have expected to be the dominant race. The brachycephalic element in these cases is probably Negrito.

The general survey which I have now taken of the craniology of the Pacific islanders, and the evidence collected by MM. de Quatrefages and Hamy, although not so full as that now brought together in this Report, have established on a sufficiently broad basis the important fact that in comparatively few of these islands, or groups of islands, are the crania restricted to either a simple dolichocephalic or brachycephalic standard. Both forms do without doubt occur in their pure state, but along with them skulls of mixed or mesaticephalic proportions are not unfrequently

[1] Krause's measurements; but Virchow puts the height index at 74·4 (*Zeitschr. f. Ethnol.*, Bd. viii. p. 291, 1876).

mingled. These variations can be sufficiently accounted for on the theory that two distinct races, a dolichocephalic Papuan and a brachycephalic Mahori, are in some islands pure, in others mingled with each other, either in distinct colonies living side by side in the same island, or by intermarriage; though on the western side of the Pacific region the brachycephalic Malay and Negrito have without doubt exercised an influence in modifying the cranial and other characters of some of the islanders in that region. But this theory, although combining a large mass of facts, yet does not overtake all the ethnological problems presented by the study of the anthropology of this extensive and widely scattered archipelago. There are certain residual quantities, of which it is not possible to give a satisfactory explanation on the supposition that these are the only races which have ever occupied these islands. I refer more especially to the remarkable archæological monuments that have been found in certain of them. Of these the megalithic remains on Ponapé or Ascension Island; the megalithic platforms, stone houses, and colossal stone sculptures of the human figure on Easter Island, the curious cruciform stone platforms on Malden's Island, the megalithic dolmens on Rotumah, to the north of the Fiji Islands, and the megalithic monuments in Tongatabu and some of the Gilbert Islands are the most noticeable. The natives appear to have no traditions of the construction of these massive remains, and to be themselves unable now to erect similar objects. The question therefore arises, have they so far degenerated from some higher grade of intellectual development as to have lost both all memory of the deeds of their ancestors and the power of executing such works, or did these owe their origin to some pre-existing race which inhabited the Pacific region. We cannot look to Australia as a centre of migration to the northwards of a race possessing a higher culture and civilisation, capable of architectural design and execution, for the aboriginal Australians are in their intellectual development and knowledge of useful arts much below either the Polynesians or the Melanesians, and besides, they are not a sea-faring people. Neither does it seem probable that, if these remains had been constructed by early Polynesian settlers, all memory of them would have departed, for there is ample evidence on many of the islands inhabited by the Polynesians of the propagation by oral tradition throughout hundreds of years of the valorous acts of their great chiefs. Mr. W. Colenso has gathered[1] from the modern Maoris a most interesting set of legends which have been transmitted for centuries from father to son; the Rev. W. Wyatt Gill has collected traditions from the Hervey Islanders embracing five or six centuries;[2] and the Rev. George Turner tells us[3] that the Samoans trace the genealogy of the chiefs of the Malietoa family for twenty-three generations.

Various theories have been advanced as to the origin of the Mahoris or brown Polynesians. They have been regarded by a few as of American descent, and as having

[1] *Trans. New Zealand Institute*, vols. i. xi. xiii. xiv.
[2] *Journ. Anthrop. Inst.*, vol. vi. p. 7, 1877.
[3] Samoa a Hundred Years Ago, London, 1884.

diffused themselves over the eastern islands of the Pacific in the course of the trade winds. Most writers have regarded their origin as Asiatic. Some of these consider that they are derived from the Malays,[1] hence the term Malayo-Polynesian so often applied to them, others again consider that both the Polynesians and Malays sprang from a common Asiatic stock, and that they both migrated from this common centre along independent routes to their respective geographical areas. Mr. W. H. Ranken considers[2] that this stock was Mongolian, as oblique eyes are common in Samoa, and in Tahiti many a Chinese labourer might be mistaken for a native. Others again think that we are to look to Hindustan for the origin of the Polynesians. Others again have accounted for the people of the Pacific, both Polynesians and Melanesians, on the theory so ably advocated by Charles Darwin that the Pacific is an area of subsidence, "and its great wide-spread groups of coral reefs mark out the position of former continents and islands," and that "the races of men now inhabiting these countries are therefore most probably the descendants of the races which inhabited these continents and islands."[3]

Dr. Krause accounts[4] for the Melanesian people of the Pacific by supposing that in prehistoric times a great south oceanic continent existed, which extended from the east of Africa up to the Indian Ocean, from which the black race spread into both Africa and the South Seas, to their present habitat. The deep sea investigations of the Challenger, as well as the absence of characteristic continental rocks in Oceanic islands,[5] have, however, by the demonstration of the great depth of the Pacific and Indian Oceans, and by the apparent absence of any great changes in the bed of those oceans since Tertiary times, thrown great doubt upon the possibility of such an extensive continent ever having had any existence in either the Indian or Pacific Oceans.

As regards the hypothesis of Mr. Wallace—that the brown and the black peoples, the Mahori and Melanesian, are merely varying forms of one great Oceanic race, the diversities of which are to be accounted for from "the old but certain effects of the varying physical conditions which have resulted in the present state"[6] of the surface of the land in Oceania —it is difficult to understand wherein such varying physical conditions could reside in islands subject to such uniform or closely allied climatic conditions, as the New Hebrides and Tonga, even on the supposition that they had at one time been the tops of continental mountains, so as to produce in one a black-skinned, frizzly-haired, dolichocephalic stock, and in the other a brown-skinned, straight-haired, brachycephalic people.

[1] Amongst recent writers the Rev. S. Whitmee has most strongly advocated the affinities between the Malays and Polynesians (*Contemporary Review*, Feb. 1873).

[2] *Op. cit.*

[3] A. R. Wallace, *Trans. Ethnol. Soc. Lond.*, vol. iii. p. 196, 1864, and Malay Archipelago, vol. ii.

[4] Die ethnograph.-anthr. Abtheilung des Godeffroy Museum.

[5] Paper by Mr. John Murray, Coral Reefs, *Proc. Roy. Soc. Edin.*, April 5, 1880, also joint paper by the Abbé Renard and Mr. Murray, *Proc. Roy. Soc. Edin.*, vol. xii. p. 495, 1884, and *Nature*, vol. xxx. pp. 84, 114, 132, 1884.

[6] Man in the Malay Archipelago, *Trans. Ethn. Soc. of Lond.*, vol. iii. p. 213.

GENERAL SUMMARY.

It is perhaps scarcely necessary that I should remind the reader that the one hundred and forty-three crania described and tabulated in this Report are from aboriginal people, living in a state of uncivilisation, in Southern Africa, Southern America, Australia, and the islands of the Pacific Ocean. That they are uncultivated aborigines is, however, a fact which should not be lost sight of in connection with this general summary of their characters.

In the first place I shall refer to noteworthy individual peculiarities observed in these crania. No skull was metopic, though in a young male Australian, a Loyalty Islander, and in two New Guinea skulls traces of the frontal suture were seen in the glabella, and in the Mallicollese it extended as high as the ophryon. The non-persistence of the frontal suture in the adult skulls of savages has been referred to by other craniologists, and is to be associated with the growth in thickness and weight of the cranial walls, the comparative simplicity of the sutures of the cranial vault, and the tendency to ossification of the sutures in adult life, which can so well be observed in the skulls of Australians, Chatham Islanders, and African negroes. In no skull was the malar bone either wholly or partially divided into two by a suture.[1] Wormian bones were present in the lambdoidal suture in Fuegian, Bush, Australian, Admiralty, Sandwich, Chatham, and Loyalty Islanders, Mallicollese and New Zealand crania; in some cases they were of considerable size, and in one Chatham islander attained the magnitude of an interparietal bone. No specific ethnological signification attaches to the presence of these bones. I have seen large interparietal bones in many European crania, and the view that an interparietal bone, the os incæ of Tschudi, had some special significance as a character of the Peruvian skull has now for many years been abandoned.[2]

In the crania of three Australians, two Admiralty Islanders, two Sandwich Islanders,

[1] Much stress has been laid by Prof. Rolleston on division of the malar bone in the Bush skull (account of Bush skulls in his collected papers, *op. cit.*). In his memoir, as well as in Prof. Wenzel Gruber's monograph, Ueber das zweigetheilte Jochbein, Wien, 1873, a copious bibliography may be found. Subsequently Dr. A. B. Meyer has communicated to the Berlin Anthropological Society (*Zeitschr. f. Ethn.* Bd. xiii. p. 330, 1881) a paper on this subject. He has met with two skulls, a Parisian and a Saxon, in 898 crania examined.

[2] See my paper, On some Congenital Deformities of the Human Cranium, *Edinburgh Medical Journal*, July and August 1865.

two New Guinea skulls, and one New Zealander, a tongue-shaped process of the squamous temporal intervened between the parietal and alisphenoid and articulated with the frontal. In the skulls of a Fuegian, two Australians, four Admiralty Islanders, four Sandwich Islanders, two Chatham Islanders, a Loyalty Islander, a Mallicollese, and a New Zealander, epipteric bones were found in the pterion on one or both sides. Owing to the squamoso-frontal articulation in the region of the pterion being a common character in many though not in all of the anthropoid apes, the occurrence of a similar articulation in the human skull has been regarded as a mark of degradation. In a paper which I wrote on the skull of the Gorilla, nearly twenty years ago,[1] I showed that the squamoso-frontal articulation although very common was not constant in the skulls of anthropoid and other apes, and that it might occur not only in the crania of savage man, *e.g.*, Negro, Hottentot, Caffre, Bushman, Sandwich islander, and Australian, but also in Hindoos, Ceylonese, and Europeans, and I stated that it was to be regarded as an individual peculiarity and not a racial character. I also referred to the triquetral bones occasionally present in the spheno-parietal suture as an approximation to this arrangement. Shortly afterwards Dr. H. Allen published observations on the Morton collection in Philadelphia,[2] and pointed out that twenty-three of the eleven hundred skulls in that collection had this articulation, viz., twelve Negroes and one each of the following:—Anglo-Saxon, Pelasgic, Swede, Chinese, Hindoo, Bengalese, Mandar, Seminole, Blackfoot and Iroquois Indian, and Esquimaux. Important memoirs on this subject have subsequently been written by Hyrtl,[3] Wenzel Gruber,[4] Calori,[5] Virchow,[6] Zuckerkandl,[7] Ranke,[8] Retzius,[9] Anoutschine,[10] Stieda,[11] and Schlocker.[12] In connection also with the non-articulation of the ali-sphenoid with the parietal, the presence and frequency of small triquetral or epipteric bones in the pterion has been inquired into, and the result has been to extend still further our knowledge of the races and varieties of men in which either a squamoso-frontal articulation or epipteric bones have been seen, so that now there is scarcely a race or variety in which they have not been described.

In each group of skulls, except the Fuegian, specimens occurred in which a suture

[1] *Proc. Roy. Soc. Edin.*, January 16, 1865.
[2] *Proc. Acad. Nat. Sci. Philad.*, No. 1, p. 137, 1867.
[3] Vergangenheit und Gegenwart des Museums an der Wiener Universität, 1869.
[4] *Mém. Acad. Sci. St. Petersb.*, 1874.
[5] Sull' anomala sutura, &c., Bologna, 1874.
[6] *Abhandl. d. k. Akad. d. Wiss. Berlin*, 1875; and *Zeitschr. f. Ethnol.*, Bd. xii. p. 1, 1880.
[7] Reise der Novara, Anthrop. Theil., p. 110, 1875.
[8] Beiträge zur Anthrop. u. Urgeschichte Bayerns, Bd. i., 1877.
[9] Finska Kranier, Stockholm, 1878.
[10] *Bull. de la Soc. d'Anthrop. de Paris*, 1878.
[11] *Archiv f. Anthrop.*, Bd. xi. p. 110, 1879.
[12] Anomalien des Pterion, *Inaugural Dissertation*, Dorpat, 1879. In addition to the above, isolated cases of squamoso-frontal articulation had previously been observed by Meckel, Owen, Henle, and von Baer.

extended from the infra-orbital foramen into the infra-orbital canal and floor of the orbit.[1] Although the presence of an infra-orbital suture, as will have been gathered from the descriptions in this Report, is a by no means uncommon occurrence in the human skull, yet very little attention has been given to it by anatomists. Prof. Wenzel Gruber has indeed, in a memoir on the infra-orbital canal,[2] figured in one skull a suture extending from the infra-orbital foramen through the lower border of the orbit into an anomalous infra-orbital canal, and a similar suture has been figured but not described by Virchow.[3] The peculiarity of the special fronto-maxillary articulation in the inner wall of the orbit in a Bush skull, and of a division of the parietal bone in an Admiralty Islander, have already been described in the Report (pp. 12, 57). Paramastoid processes occurred in a Bush, a Fuegian, two Sandwich Islanders, and a Chatham Islander. A mesial third occipital condyle was present in an Admiralty Islander, a Sandwich Islander, a Chatham Islander, and a New Zealander. Dr. H. Allen states that in the Morton collection of crania ten specimens possessed a third occipital condyle, and Dr. Barnard Davis also mentions several specimens in his collection as possessing it. The spheno-pterygoid foramen was seen in the skulls of two Sandwich and a Chatham Islander. In some other specimens although the external pterygoid and sphenoidal spine were not quite continuous, yet they so closely approached that in the living head they had probably been connected by a fibrous band, the pterygo-spinous ligament of Civinini.

Exostoses from the wall of the external auditory meatus were found in four Sandwich Islanders, a Chatham Islander, and a New Zealander. From observations which I have elsewhere recorded on this subject,[4] I was at that time led to state that there was a tendency to the development amongst the aborigines of America of modifications in the configuration of the external auditory passage. If, along with the crania described in this Report, we were to include the Marquesas Islanders described by Prof. Welcker[5] and Dr. Barnard Davis,[6] and the Sandwich and Loyalty Islanders in the collection formed by the latter craniologist, we should also be justified in saying that exostoses in this locality are not uncommon amongst the South Sea Islanders. The skull from the Admiralty Islands, with the remarkable deficiency of the nasal bones, exhibited a rare though not a unique malformation, as Van der Hoeven has referred[7] to a similar condition in a Bush skull, and the skulls of two African negroes in the Barnard Davis collection[8] have no nasal bones. The general absence of decay in the teeth, notwithstanding the frequent

[1] I have omitted, I find, in the description of the Bush crania, to refer to this character, but this suture was present in one skull of that race.

[2] *Mem. Acad. Sci. St. Petersb.*, 1874.

[3] Niedere Menschenrassen, *Abhandl. d. Berlin Akad.*, pl. vi. fig. 1, 1875.

[4] On Exostoses within the external Auditory Meatus, *Journ. of Anat. and Phys.*, vol. xiii. p. 200.

[5] *Archiv. für Ohrenheilkunde*, vol. i.

[6] Thesaurus Craniorum, and Supplement.

[7] Catalogus Craniorum, No. 165, p. 58, 1860.

[8] Thesaurus Craniorum, pp. 206 208, Nos. 1461, 1066.

exposure of the dentine as a result of use, is in accordance with the observations of many craniologists, that primitive man is much less subject to diseases of the teeth than man in a more civilized condition.[1]

Of the several peculiarities above described, some, such as the presence of an inter-parietal bone, a squamoso-frontal articulation in the pterion, a maxillo-frontal articulation in the inner wall of the orbit, a spheno-pterygoid foramen, and paramastoid processes are arrangements which are normal in various mammals though not in man. When they appear in the human cranium they are reversions to a lower type, and it is not without interest to consider if such reversions occur more commonly in savage than in civilised races.

The one hundred and forty-three crania described in this Report were collected without any reference to individual anatomical peculiarities, but simply as the skulls of races of men, which happened to come in the way of myself and other collectors. But amongst them, although their number is certainly too limited to base any broad generalisation on, as to the relative frequency of occurrence of particular variations in the different races, there is obviously a larger proportion of important variations than would occur in a corresponding number of skulls of the white races. Take the squamoso-frontal articulation, for example. It was seen in ten skulls, whilst epipteric bones were present in sixteen crania, which gives for the squamoso-frontal joint a proportion of 7 per cent., and for the epipteric bones a proportion of 11 per cent. This proportion is very much larger than was observed by Prof. Ranke in a series of two thousand four hundred and twenty-one crania of old Bavarian people, in which forty-three specimens had a complete articulation of the frontal with the squamoso-temporal, being in the proportion of 1·7 per cent. Virchow has added to Ranke's series of old Bavarian skulls observations on upwards of one thousand collected from other parts of Germany, so as to make a total of three thousand six hundred and ten German skulls, in 1·6 per cent. of which this articulation occurred. Calori also found this articulation in Italian skulls ten times in one thousand and eighteen specimens, or 1 per cent. Wenzel Gruber observed it in sixty crania in his collection of four thousand specimens. These crania represented different nationalities of Russia, and were probably for the most part Sclavonic, and the proportion is 1·5 per cent. These observations give a proportion of something less than 2 per cent. of European crania in which the squamous-temporal articulated with the frontal. We have no correspondingly large observations on the coloured races, but the frequency with which this variation has been noticed in certain of them shows that it is not uncommon. I have already referred (p. 116) to Dr. Allen having seen it in twelve Negroes in the Morton collection, which, judging from Dr. Aitken Meigs's Catalogue,[2] contains one hundred and seventeen negro skulls. Ecker found it ten times in the series of fifty negro crania in

[1] See especially the remarks made by Prof. Rolleston in British Barrows, p. 701.

[2] Philadelphia, 1857.

the collection in the Freiburg Museum. Anoutschine puts its occurrence in the negro skull at 12·8 per cent. He also gives its proportion in the Papuan skulls, based on the observations of A. B. Meyer and Mantegazza on three hundred and thirty-six skulls, at 6·9 per cent., and on thirty-nine crania examined by himself at 5·1 per cent. Flower found it in the Australian skulls examined by him in the proportion of 9 per cent.,[1] but Virchow, who has summarised[2] observations by various authors on one hundred and forty-two Australian crania, places it at 16·9 per cent. On the other hand the squamoso-frontal articulation does not appear to have been seen in any Tasmanian skull. Anoutschine gives the proportion of its occurrence in one hundred and eighty Polynesian crania at 3·3 per cent. and in one hundred and sixty-six Malay skulls at 4·8 per cent.[3]

The spheno-pterygoid foramen is also a variation of considerable interest in the human skull. It was seen with complete osseous boundaries in three of the skulls on which I have reported. A memoir on this foramen has recently been written by Dr. Eugen Roth,[4] who states that he has seen it with complete bony boundary ten times in two hundred and seven European crania, *i.e.*, 4·8 per cent. He puts its percentage with partial and complete bony walls, amongst exotic crania very much higher, 32 per cent. in Asiatics; 50 per cent. in Australians and Papuans; 30·6 per cent. in Africans; and 20 per cent. in American Indians, but the number of skulls of these coloured races which he has examined is far too small on which to frame any sound generalisation.[5]

In addition to the measurements of the crania recorded in the several Tables printed in the early part of this Report, I selected at least one characteristic specimen of each group of skulls, and bisected it longitudinally and vertically immediately to one side of the septum nasi and mesial plane of the cranial cavity. A careful rubbing was then taken of the outline of the section of each skull, and on this several lines were drawn and angles measured. As to the importance of this method of studying the skull I am quite in accordance with Profs. Huxley[6] and Cleland.[7] Indeed I may say that I had looked at the comparative anatomy of the skull from this point of view many years ago, when I

[1] Native races of the Pacific Ocean.

[2] *Zeitschr. f. Ethnol.*, Bd. xii. p. 20, 1880.

[3] Dr. Schlocker in his *Inaugural Dissertation*, Dorpat, 1879, "Die Anomalien des Pterion," discusses how the squamoso-frontal articulation arises, and this question is also considered by J. B. Sutton in *Journ. Anat. and Phys.*, vol. xvii. p. 220, 1884. It would seem as if an epipteric bone is normal in the development of the human skull, and usually joins the parietal to form its antero-inferior angle. If it fuses instead with the squamosal or frontal then it connects those bones and cuts off the parietal from the ali-sphenoid. Sometimes it remains up to adult life as a distinct epipteric bone.

[4] *Archiv f. Anthrop.*, Bd. xiv. p. 73, 1882.

[5] I may also refer to Dr. Krause's measurements of the skulls in the Godeffroy Museum, for several examples of this and the other forms of cranial variation described in the text.

[6] Two widely contrasted forms of the Human Cranium, *Journ. Anat. and Phys.*, p. 60, Nov. 1866.

[7] Variations of the Human Skull, *Phil. Trans.*, 1869; and Description of a Sulu Skull in *Journ. Anat. and Phys.*, p. 663, July 1877.

was working at the anatomical relations of the tentorium to the cerebrum and cerebellum.[1] The modifications in the thickness of the two tables and of the diplöe of the bones of the cranial vault, and the extent of the frontal and sphenoidal sinuses are revealed in such sections. It is interesting to observe that the massive skull of the Chatham Islander and that of the New Zealander had no frontal sinus in the glabella; in the Bush skull this sinus had both great vertical and lateral extension.

In the first place, I have drawn from a common centre a number of radii to definite points on the surface in the mesial line of the outer table. The centre I have selected is the basion, to the importance of which I have already referred in the introduction to this Report. I have also drawn a line in the plane of the foramen magnum and erected a

TABLE XVIII. (Plates VI., VII.)

RADII.	Bush. Umzimkulu.	Fuegian. D.	Admiralty Islander. A.	Oahu. D.	Hawaii. B.	New Zealand. Waikato.	Chatham Islander. A.	Queensland, Australia.	Gipps Land, Aust.	Australia.
Basi-occipital,	94	108	110	110	103	96	106	113	105	104
Basi-lambdoidal,	111	123	120	130	122	112	120	115	111	110
Perpendicular,	129	139	147	147	146	138	144	132	126	128
Basi-coronal or bregmatic,	130	138	144	146	143	134	144	135	124	133
Basi-glabellar,	107	111	106	113	108	110	121	108	101	114
Basi-nasal,	104	106	100	107	102	104	113	97	95	102
Basi-alveolar,	99	102	98	110	100	101	106	100	94	108
From perpendicular radius to most anterior part of cranial cavity,	89	79	82	80	87	88	92	94	83	91
From perpendicular radius to most posterior part of cranial cavity,	75	84	87	84	74	71	76	73	82	72

perpendicular from the anterior end of this line at the basion, which intersects the cranial vault at a point behind the bregma. This point varies within certain limits in different skulls according to the inclination of the plane of the foramen magnum, for it is thrown backwards or forwards according as that plane diverges from or approaches the horizontal plane of the head. Speaking generally, it may be said to touch the cranial vault in more or less close proximity to the spot which corresponds to the upper end of the fissure of Rolando.[2] In the Admiralty Islander it was 18 mm., in the Oahuan 19, the Fuegian 22, the Chatham Islander 23, the Hawaian 31, the New Zealander 34, the Bush 37, one

[1] *Proc. Roy. Soc. Edin.*, March 3, 1862. The drawings and tracings which I made at that time have not been published.

[2] See my papers On the Relations of the Convolutions to the Outer Surface of the Skull and Head, in *Journ. Anat. and Phys.*, vol. viii. pp. 142 and 359; also Mr. Hare's paper in the same *Journal*, vol. xviii. p. 174.

Australian 26, another 44, another 55 mm. behind the bregma. There are two factors which influence the relation of this point to the bregma, viz., the inclination of the plane of the foramen magnum and the relative length of the longitudinal arc of the frontal bone. This line I shall call the perpendicular radius, and the extent of cranial cavity which lies anterior to it, and in relation to the cranial vault, will approximately correspond to the frontal lobes of the cerebrum. I have constructed Table XVIII., in which is given the length of these different radii expressed in millimetres in the series of skulls which have been measured, and to them I have also added for convenience of reference the basi-nasal and basi-alveolar diameters obtained in the previous measurements by the callipers. The new radial measurements are as follows:—basi-occipital from basion to occipital point; basi-lambdoidal from basion to lambdoidal suture; perpendicular from basion to cranial vault perpendicular to plane of foramen magnum; basi-glabellar from basion to the most projecting part of the glabella; whilst the basi-coronal from basion to coronal suture, corresponds with the basi-bregmatic diameter.

From the perpendicular radius the distance was measured to both the most anterior and most posterior parts of the cranial cavity, and these measurements are also recorded in this Table. It will be seen that in the dolichocephalic Fuegian, Admiralty Islander, and Oahuan skulls, the extent of brain cavity behind the perpendicular radius exceeded that which was in front by several millimetres; in the mesaticephalic Bush, New Zealander, and Chatham Islander, and in the brachycephalic Hawaian, on the other hand, a larger proportion of the cavity was in front of than behind the perpendicular radius.

It would seem therefore as if in the formation of some dolichocephalic skulls, the growth takes place backwards, behind the plane indicated by the perpendicular radius, to a greater extent than in front of the same plane. This remark, however, must not be made too absolutely, for, owing to the plane of the foramen magnum not always possessing the same definite relation to the horizontal plane of the head, the perpendicular radius may, as already stated, be moved forwards and backwards. Thus in two of the three dolichocephalic Australian skulls measured in the above Table, where the plane of the foramen magnum sloped backwards, the frontal division of the cavity exceeded the occipital by a number of millimetres; but in the dolichoplatycephalic Gippsland skull, where the perpendicular radius reached the cranial vault much closer to the bregma, the anterior and posterior divisions of the cranial cavity were nearly equal. It will also be seen that, in accordance with the development of the cranial cavity behind the perpendicular radius, the basi-occipital and basi-lambdoidal radii attained considerable magnitude in the dolichocephali, and in the brachycephalic and mesaticephalic skulls the basi-glabellar radius preponderated over the basi-occipital. The tapeinocephalic character of both the Bush and Gippsland crania is well shown by the shortness of both the perpendicular and basi-bregmatic radii.

Another relation to which my attention has been directed is the angle which a line

drawn from the basion through the basi-occipital and sphenoid bones to the sphenoido-ethmoid articulation in the anterior cerebral fossa, forms with a line from the same point in the sphenoido-frontal articulation drawn parallel to the cribriform plate of the ethmoid through the upper end of the ethmo-frontal suture. These lines, which I shall call the basi-occipito-sphenoid axis and the cribriform axis, and the angle formed by their intersection, the sphenoido-ethmoid angle, have been studied by Prof. Huxley,[1] and to the first of the two lines he has given the name of basi-cranial axis. Almost similar lines have also been drawn by Prof. Cleland[2] and named by him the middle base and the frontal base, whilst the plane of the foramen magnum he regards as the hindmost division of the base of the skull. The length of these lines expressed in millimetres and the angle formed by their intersection in the same skulls as those measured in Table XVIII. are given in Table XIX. The angle which the basi-occipito-sphenoid axis forms with the plane of the foramen magnum is named the foramino-basal angle in the same Table.

TABLE XIX. (Plates VI., VII.)

Collection,	Bush. Umzimkulu.	Fuegian. A.	Admiralty Islander. A.	Oahu. D.	Hawaii. B.	New Zealand. Waikato.	Chatham Island. A.	Australia. Queensland.	Australia. Gippsland.	Australia.
Basi-occipito-sphenoid axis,	59	64	64	66	65	69	70	59	55	63
Cribriform axis,	28	29	30	22	21	21	24	34	28	28
Sphenoido-ethmoid angle,	142°	139°	148°	148°	147°	154°	150°	136°	138°	138°
Foramino-sellar angle,	126°	125°	115°	123°	130°	140°	132°	129°	124°	127°
Foramino-basal angle,	147°	138°	143°	140°	146°	151°	146°	157°	139°	150°
Spheno-maxillary line,	72	79	72	73	69	72	79	79	72	85
Spheno-maxillary angle,	94°	89°	90°	101°	93°	92°	91°	91°	93°	93°
Base line,	136	137	128	140	135	135	144	130	127	136
Frontal chord,	113	109	121	113	113	112	122	118	102	108
Parietal ,,	113	111	127	104	114	106	108	121	115	119
Occipital ,,	91	103	96	111	103	96	103	99	87	91

The basi-occipito-sphenoid axis is not necessarily parallel to the plane of the surface of this part of the cranial base, *i.e.*, to the dorsum sellæ, so that the angle which it makes with the plane of the foramen magnum does not express how far the slope of the dorsum sellæ approaches or departs from the perpendicular radius. I have accordingly drawn a line parallel with the dorsum sellæ to cut the plane of the foramen, and have inscribed the angle formed by their intersection in Table XIX. as the foramino-sellar angle. It will be seen that the inclination of the dorsum sellæ to the plane of the foramen magnum exhibited a considerable range of variation in the series of crania measured. In the Admiralty Islander it approached closer to a right angle than in any of the others, whilst in the New Zealander it opened out to 140°. Very little variation in the foramino-sellar angle occurred in the three Australian skulls. The foramino-basal angle formed by the

[1] Two widely contrasted forms of Human Skulls, *Journ. Anat. and Phys.*, November 1866.

[2] Description of a Sulu skull, *Journ. Anat. and Phys.*, July 1877.

basi-occipito-sphenoid axis with the plane of the foramen magnum presented considerable variations in the different crania; in the Fuegian it was the lowest, 138°, and it reached its maximum in one of the Australians 157°, but amongst the three Australians it ranged from 139° to 157°. In each skull it was more open than the foramino-sellar angle in the same cranium.

The sphenoido-ethmoid angle presented considerable variation in these crania. Prof. Huxley, in speaking of his corresponding angle, which he calls the basi-ethmoid angle, states that it diminishes in proportion to the downward rotation of the cribriform plate, *i.e.*, in proportion to the departure of the human skull from the arrangement of that plate seen in the lower mammalia. But the cribriform axis is not the only factor in the formation of this angle, for the slope of the basi-occipito-sphenoid axis is not uniform in all crania, and the nearer that the latter axis approaches to the vertical the more would the sphenoido-ethmoid angle be diminished, just as if a downward rotation of the cribriform plate had taken place. Table XIX. shows that this angle possessed a considerable range of variation. It was most open in the New Zealander and Chatham Islander, whilst in the three Australians and the Fuegian it was almost uniform at from 136° to 138°.[1]

A line was also drawn from the spheno-ethmoid articulation to the most projecting point of the upper jaw-bone and named in the Table the spheno-maxillary line, and the spheno-maxillary angle, which it formed with the basi-occipito-sphenoid axis was measured. The spheno-maxillary line varied considerably in length in the several skulls. It was shortest, 69 mm., in the brachycephalic, mesognathic Hawaian, and it attained its maximum, 85 mm., in a dolichocephalic, prognathic Australian, the gnathic index of which was 105·8. It possessed also considerable length, 79 mm., in the Chatham Islander and Fuegian skulls, but in neither of these did the gnathic index exceed 98, so that these crania were not prognathic. There was comparatively little variation in the spheno-maxillary angle which, in the majority of the skulls measured, exceeded by a very little a right angle, though in the Fuegian A it sank to 89°, and in the prognathic Oahuan D it rose to 101°. The projection of the upper jaw is not the only factor which affects this angle. Undoubtedly when the forward projection of this bone is considerable the tendency of this angle is to become more open, but should the slope of the basi-occipito-sphenoid axis at the same time approach the vertical then the angle would be relatively diminished. Hence I cannot regard this angle as giving an accurate measure of the degree of prognathism.

The base line from the back of the foramen magnum to the fronto-nasal suture, proposed by Prof. Cleland is also given in Table XIX., and as the total longitudinal arc

[1] Prof. Goodsir says that in man the cribriform side of this angle is, in well formed heads, horizontal. In the descending animal series this side rises so as at last to assume the rectangular position (see Lectures on the Dignity of the Human Body, in collected Anatomical Memoirs, vol. i. p. 258. Edinburgh, 1868).

of the vault of the several crania, except that of the Australian in the last column, has been given in the previous Tables under their respective headings, the relation as regards the relative length of the one to the other can be easily computed. Of the Australian skull, a male above referred to as excepted, I possess only one half, so that I have not included it in either Tables III. or IV., but I may state here that its total longitudinal arc is 374 mm.—the frontal 130 mm., parietal 125 mm., occipital 119 mm.

The chords of the frontal, parietal, and occipital arcs are also recorded in Table XIX. As Dr. Cleland has pointed out in his paper on the Sulu skull, the occipital arc possesses in dolichocephalic skulls a very pronounced curvature. The contrast between the curvature of that bone in the dolichocephali figured in Plates VI. and VII., and the corresponding bone in the brachycephalic Hawaian is very marked. There is obviously no relation between the length of the basi-occipito-sphenoid axis, and either the absolute length of the skull or its length relatively to its breadth. Thus this axis in the brachycephalic Hawaian varied only one millimetre in length from the same axis in the dolichocephalic Fuegian, Admiralty Islander, and skull from Oahu, and only 2 mm. from one of the dolichocephalic Australians, a result which accords with the observations made by Prof. Huxley on his two widely contrasted forms of skulls. As regards the relations of the transverse diameters of the side walls of the skull to the length of this axis, it will be seen that the stephanic and parietal diameters were greater in the Hawaian than in the Admiralty Islander, Fuegian, and Oahuan, but that the asterionic diameter, though greater in the Hawaian than in the Oahuan, was less in it than in the Fuegian and Admiralty Islander. It would seem therefore as if in brachycephalic as compared with dolichocephalic crania, a greater transverse growth took place in the frontal and parietal regions than in the occipital. The degree of what Prof. Huxley calls the anterior and posterior cerebral overlap may also readily be determined with the aid of the sectional diagrams in Pl. VI. and VII., and the posterior overlap is obviously less in the brachycephalic than in the dolichocephalic skulls.

I may supplement the remarks made in the Introduction on the method of taking the cranial capacity by stating that in the comparative measurements of each skull made by Mr. Jas. Simpson and myself, our measurements corresponded twenty-two times; on twenty-three occasions the difference between us was 10 cc., and in the remaining seventy-four the difference was between 2 and 8 cc. I think therefore it may fairly be assumed that any two persons carefully carrying out a series of observations on the cubic capacity in the manner I have recommended, ought to arrive at results closely corresponding with each other, which may be taken as giving a fair approximation of the internal capacity of the crania examined. The series of observations showed very decidedly that in these savage people the mean cubic capacity of the female skull was distinctly below the male.

Although my Tables do not record the breadth as well as the length of the foramen

magnum, I have taken both these dimensions in a large number of the crania. In far the greater number the length exceeded the breadth—in the Bush skull Chal. B. by as much as 12 mm.—but usually the difference between them was much less, sometimes not more than 1 mm. In one New Zealander and in one Chatham Islander these dimensions were equal. In one Admiralty Islander the breadth exceeded the length by 1 mm., in another by 0·5 mm.

Variations occurred in the series of skulls in the relative width of the face as estimated in the interzygomatic diameter, and that of the cranium in the parietal or parieto-squamous region. In the mesaticephalic Bush and Chatham Islanders, the brachycephalic Hawaians and Oahuans, and the dolichocephalic Admiralty Islanders, the rule was for the interzygomatic diameter to be less than the interparietal; in the male Australians as a rule the interzygomatic was the greater diameter, but in the Fuegians and New Zealanders these relative diameters varied in different crania. In many specimens the greater interparietal breadth was associated in the same cranium with a relatively large interstephanic breadth, so that the skull was cryptozygous; but this was not constant, so that in some of the crania examined the breadth in the parietal region was greater than the interzygomatic diameter, and yet the skulls were phænozygous.

The relative length of the frontal, parietal, and occipital arcs varied materially in the crania under review. As a rule the occipital longitudinal arc was the smallest of the three, but in the Fuegian and so called Patagonian group of skulls the occipital arc was in the majority of the specimens longer than either the frontal or parietal. The relative length of the frontal and parietal arcs was very inconstant. In the whole series of crania, except the New Guinea, the Loyalty and Admiralty Islanders and New Hebrideans, the tendency was for the frontal arc to exceed the parietal, but in the Melanesians it was the rule for the parietal arc to be longer than the frontal, and in the Loyalty Islanders very considerably to exceed it, so that this may be considered as a racial character of the Papuans. In a paper on Cranial Deformities, published twenty years ago, in which I discussed the mode of production of the scaphocephalic skull[1] I stated that one cranial bone might infringe upon the areas of adjacent bones if its ossification proceeded at a more rapid rate than theirs. This will doubtless account for the variations in the relative magnitude of the cranial bones, more especially those of the vault of the skull, in different individuals. For the fibrous primordial matrix in which these bones arise is continuous over the cranial vault, and does not have the limits of the several bones defined in it by sharp lines of demarcation. The ossific spicules, growing at a greater rate from a centre within one area than in the others surrounding it, would necessarily extend the area of the bone to which they belong and give it a greater superficial magnitude. It is probable that in those Melanesian crania in which the parietal longitudinal arc dominates so much over the frontal and occipital, that the parietal ossific centres are relatively more active than both

[1] *Natural History Review*, January 1864.

the frontal and occipital. Skulls which owe their dolichocephalic proportions to this dominating growth of the two parietal bones may appropriately be said to exhibit parietal dolichocephaly. The variations in the length of the arcs in the bones of the cranial vault will necessarily affect the cranial sutures, so that the coronal, squamous, and lambdoidal sutures will vary both in their direction and position within certain limits. As we have no evidence that the lobes of the brain grow commensurately with the bones of the cranium after which they are named, the relation which these lobes, and the fissures separating them from each other, will bear to the cranial sutures will also, as I[1] and others have elsewhere pointed out, vary within certain limits, and these variations will render it difficult to lay down, from an inspection of the surface of the head, absolutely fixed rules for the determination of the position of the cerebral fissures and convolutions.

TABLE XX.

	Bush.	Fuegians.	Australians.[2]	Admiralty Islanders.	Hawaiians.	Oahuans brachycephali.	Oahuans dolichocephali.	Oahuans mesaticephali.	Chatham Islanders.	New Zealanders.	New Guinea.	South Sea Islanders.
Cephalic Index, . .	1·5	5·	9·	5·5	2·	5·	3·	4·	8·	11·	19·5	9·6
Vertical ,, . .	4·	3·5	11·	13·	4·	3·	9·	8·	7·	9·	7·5	10·
Gnathic ,, . .	9·4	3·	16·	18·	7·	5·	14·	11·	8·	11·5	13·	11·
Facial ,, . .	7·	14·	17·	14·	6·	7·	12·	7·	9·8	21·	13·	12·
Nasal ,, . .	14·5	8·	14·5	17·	11·	12·	11·	10·	12·	20·	10·	4·
Orbital ,, . .	13·	10·	23·	19·	8·	23·5	16·	9·	15·	20·	18·	30·5
Palato-maxillary Index,	16·	6·	23·5	17·	10·	19·	27·	15·	13·	22·	32·	21·

The great importance which has been attached, in the later years of craniological research, to a determination of indices, by a comparison of two dimensions, leads me now to survey the several indices which I have computed in the preceding Tables, with the object of ascertaining which index shows the smallest range of variation in each series of skulls. For convenience of comparison I have arranged in groups in Table XX. the series of skulls examined, and the numerals express the range of variation in their several indices in the adults of each group. From this Table it will be seen that the cephalic and vertical indices showed the smallest amount of variation in each group. In the Bush skulls 1·5 expressed the range of the cephalic index, and in no group did it rise above 10, except in such mixed people as the New Zealanders, where it reached 11, and the New Guinea skulls, which included both brachycephalic and dolichocephalic races. The vertical index was remarkably constant in the Bush, Fuegians, Hawaians, and brachycephalic Oahuans, the range of variation not rising above 4. In the Australians the range was 11, owing to the presence of a proportion of dolichoplatycephalic crania, and

[1] See *Journ. Anat. and Phys.*, vol. viii. pp. 142 and 359.

[2] In estimating the range of variation of the cephalic index in the Australian skull, I have not included the scaphocephalic man from Portland Bay, or the mesaticephalic woman from West Victoria.

the range of 13 in the Admiralty Islanders was due to one skull having the unusually low vertical index of 64. As regards the sexes, my measurements generally confirm those made by preceding craniologists, who give to the female skull a less absolute and relative height than to the male. The gnathic index showed a much greater amount of variation in the several groups than the cephalic and vertical; in only five was the range below 10, whilst in the remaining seven it rose above that figure, and in the Admiralty Islanders was as high as 18. The greatest variation was, however, in the facial, nasal, orbital, and palato-maxillary indices, in which the range was seldom below 10; in several groups the range of one or other of these indices rose to 20, and in two instances to upwards of 30. In his important essays on the orbital and nasal indices[1] Paul Broca fully recognises the variations which may occur in these two indices, and, when writing on the nasal index, he states that it is subject more than most of the other characters to the perturbing influence of individual variations, so that valuable results can only be obtained by taking the average of a sufficiently large number of skulls. My observations on those groups, in which I had a sufficient number of crania of the two sexes, confirm the statement of Broca that in the same race the orbital index in the adult females is higher than in the adult males.

As the palato-maxillary indices in this Report are derived from the examination of the palato-alveolar arch in the crania of uncivilised races, it may be interesting to state the results of the length and breadth measurements of this region in a number of European crania. Twenty male skulls, consisting of ten Scots, five French, and five Germans, had a mean palato-maxillary index of 116·2, *i.e.*, they were brachyuranic, and the range of variation was from 103 to 138. Only three were below 110, *i.e.*, were dolichuranic; seven were between 110 and 115, *i.e.*, mesuranic, and the remaining ten were all above 115; one half, therefore, were brachyuranic, and as many of these had a high index, they raised the mean index of the crania measured. Eight female skulls, consisting of five Scots and three Sclavonic skulls, had a mean palato-maxillary index of 115·6; and they also were in the mean brachyuranic, and the range of variation was from 108 to 121·6. Only one was dolichuranic, three were mesuranic, and the remaining four were brachyuranic. The male and female averages corresponded, therefore, very closely with each other. The greatest length of the palato-maxillary arch in the series of European skulls was 60 mm. (male), and the shortest arch was 47 mm. (male), the widest arch was 69 mm. (two males), and the most contracted arch was 56 mm., both in a male and a female. In no specimen was the length of the region equal to the breadth.

In the series of skulls tabulated in this Report the Australians possessed the largest palato-alveolar arches. The longest arch in this race was 68 mm., and the shortest 48 mm., whilst the widest arch was 74 mm., and the most contracted 53 mm. The New

[1] *Revue d'Anthropologie*, 1875 and 1876.

Zealand crania also contained specimens of considerable magnitude, the longest arch was 62 mm., the shortest 49 mm., the widest was 69 mm., and the most contracted 57 mm. As a rule the breadth of the arch was markedly greater than the length, but in a few crania they approximated to each other and gave rise to a low palato-maxillary index. This was especially seen in the Australians (p. 39). One Admiralty Islander also had a palato-maxillary index of only 104, but the gnathic index in this specimen was moderate. In one dolichocephalic skull from Oahu the palato-maxillary index was only 103, and the gnathic index was moderate; in two others the length and breadth of this arch were equal, and in one of these the gnathic index was prognathous, in the other orthognathous. Although, as already stated in the description of the Australian crania, a dolichuranic palate is frequently associated with prognathism, it by no means follows that they should of necessity go together.

A long palato-alveolar arch is to be regarded as a sign of degradation of the human cranium, and this is the more marked when it is associated with relative narrowness and the consequent production of a low palato-maxillary index. In the anthropoid apes, for example, the length of this region in the adult skull is invariably considerably greater than the breadth, so that the palato-maxillary index is very low. Five skulls of the Gorilla in the Edinburgh University Anatomical Museum have a mean index of only 72, a single adult Orang has an index of 80, and an adult Chimpanzee an index of 82. In the young of the anthropoid apes, as I have determined from the measurements of three young Orang skulls in the same Museum, the length and breadth of the palato-alveolar region closely approximated, and the breadth in one even slightly exceeded the length, so that the index was considerably higher than in the adult. In the youthful stage of the human cranium, owing to the non-development of the true molars and the consequent shortness of the dentary arcade, the breadth of the arch is also greater in proportion to the length than in the adult skull, and the palato-maxillary index is very high. Illustrations of this may be seen in several of the young skulls, the measurements of which are given in the Tables.

Owing to the greater constancy of the cephalic and vertical indices in the same people, it follows that they are the most important features of study to guide the craniologist in his determination of the distinctive characters of races, for it is obvious that the less liable to variation any character is, the more does it stamp the race to which it belongs. The gnathic index ranks also very high as a racial feature, whilst the other indices to which I have referred are only of secondary importance. One cannot therefore but express a feeling of admiration at the acuteness of Anders Retzius, who so many years ago, and with much less refined methods than those employed in modern craniometry, seized upon the relation of the length to the breadth of the cranium, and on the relative amount of projection of the upper jaw as the foundation of his classification of the various races of mankind.

In upholding, however, a system of classification based upon these and other proportions of the skull, I do not wish it to be supposed that I undervalue the importance of other physical characters. The colour of the skin, the colour and character of the hair and eyes, the shape of the nose and lips, the stature, and the form of the pelvis, are all important factors in the determination of the distinctive physical features of races. To say that a series of skulls is dolichocephalic, or that another series is brachycephalic, is merely to express that they have in common a certain relation of length and breadth of the cranium, and by no means indicates that all the dolichocephali belong to one race only, and all the brachycephali to another. But I believe that by taking a combination of cranial characters we can lay down certain propositions as regards unmixed races of men, which, whilst allowing for the occurrence of occasional individual variations, will be as distinctive as those afforded by the study of any other series of physical characters. For variations occur in such characters, as in the cranium itself, and no more striking illustration could be given than the occasional appearance of an albino amongst the coloured races.

In unmixed races, where the skull is markedly dolichocephalic, brachycephalic skulls, one may say, never occur; and similarly in unmixed races, where the skull is markedly brachycephalic, dolichocephalic skulls are not met with. Hence even an unskilled observer would have no difficulty in distinguishing the skull of a Melanesian Loyalty Islander from that of an Andamanese, or that of an Australian from a brachycephalic Sandwich Islander. Similarly the dolichocephalic skull of an African negro, or of a Kaffir, may be readily differentiated from that of a mesaticephalic Bushman. Mixed races again are more difficult to deal with, especially if the mixture be that of a dolichocephalic with a brachycephalic race. For the people resulting from such a mixture will of necessity present many diversities in cranial form. Some will have heads which exhibit, with but little variation, the characters of one or other of the two parent types, but in others intermediate characters will arise, which may incline in some to those of one parent type, in others to those of the other. It is I think through the want of a due recognition of the effects which may be produced on the form of the head by this mixing of races that discredit has been thrown on the value of the skull in the determination of racial characters.

The question may be fairly discussed whether all unmixed races are either dolichocephalic or brachycephalic, and whether mesaticephalic people are invariably due to a mixture with each other of races possessing the two extreme types of head form. There can, I think, be no doubt that the dolichocephalic African negro, the hypsistenocephalic Melanesian, and the dolichocephalic Esquimaux, are all unmixed races. Their cranial and other physical characters are so decided that each of these people is distinctively differentiated from all other races. Similarly the brachycephalic Andamanese, Mongolians, and American Redskins are distinguished by definite characters from each other and from other races. I

have in previous pages given many examples to show how a mesaticephalic people may arise from a mixture of a dolichocephalic with a brachycephalic race. But there are instances of apparently unmixed races in which the standard form of the head is mesaticephalic. I may especially refer to the Bush race of South Africa, which has so many features distinguishing it from the surrounding people that it would seem to be a pure race, and it is not improbably the remains of the primitive people of the African continent. The Tasmanians were mesaticephalic, and it is possible also an unmixed race, though on this point I hesitate to give a definite opinion. I am not disposed, therefore, to limit the unmixed races to those which are either dolichocephalic or brachycephalic in their cranial proportions, but to include also certain of the mesaticephali.

From the examination of the Races of Men described in this Report, we have seen that in South Africa, in the southern part of South America, and in Australia, races of men exist distinguished by the small capacity of their crania, by their low intellectual development, and in the case of the Bushmen and Fuegians by their small stature and generally feeble physical configuration. The Australians also and the now extinct Tasmanians were under the average size of Europeans. In the islands to the south and east of the great Asiatic continent the Andamanese and other Negrito tribes are distinguished by their small stature, microcephalic crania, and low state of intelligence. It is not unlikely that these people may in the early unwritten periods of human history have had in their respective continents a much wider range of distribution than at present, and have been gradually pushed southwards into their present restricted areas by the advance of the races, more powerful in both intellectual and physical development, which we see around them. If in their displacement they failed to mix with their invaders their physical characters would remain pure. For isolation and interbreeding carried on through many centuries would necessarily preserve and even intensify the characteristic structural peculiarities of each race.

PLATE I.

PLATE I.

Fig. 1. Facial view of the skull of a Bushman from the mountain district at the source of the Umzimkulu river; one-half natural size (Table I.).

Fig. 2. Profile view of the same skull; one-half natural size.

Fig. 3. Vertex view of the same skull; one-fourth natural size.

Fig. 4. Base and inner wall of the orbit of the same Bush skull, showing a direct articulation between the orbital plates of the maxillary and frontal bones.

E., Os planum of ethmoid.
L., Lachrymal.
Mx., Orbital plate of superior maxilla.
F., Frontal.
M., Malar bone.

Fig. 5. Facial view of the skull of the Fuegian D. (Table II.); one-half natural size.

Fig. 6. Profile view of the same skull.

Fig. 5.

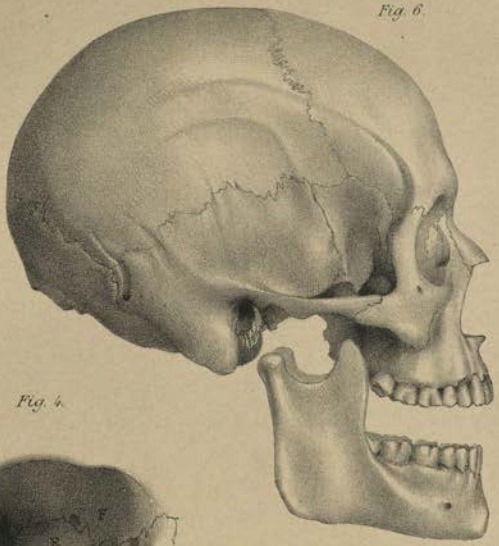


Fig. 6.

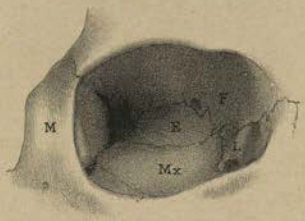


Fig. 4.

Fig. 1.

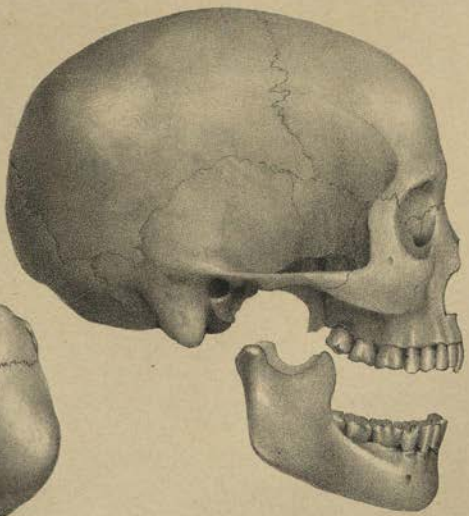


Fig. 2.

Fig. 3.

W. Turner dir. F. Huth, Lith. Edin.

FIGS 1-4, BUSHMAN. FIGS 5 & 6, FUEGIAN.

PLATE II.

PLATE II.

Fig. 1. Facial view of the Australian skull from Riverina, New South Wales (Table III.).

Fig. 2. Profile view of the same skull.

Fig. 3. Facial view of the Australian skull from Roebuck Bay (Table IV.).

Fig. 4. Profile view of the dolicho-platycephalic skull, No. 1 from Gipps Land, Victoria (Table V.).

The whole of the Figures in this Plate are one-half natural size.

Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

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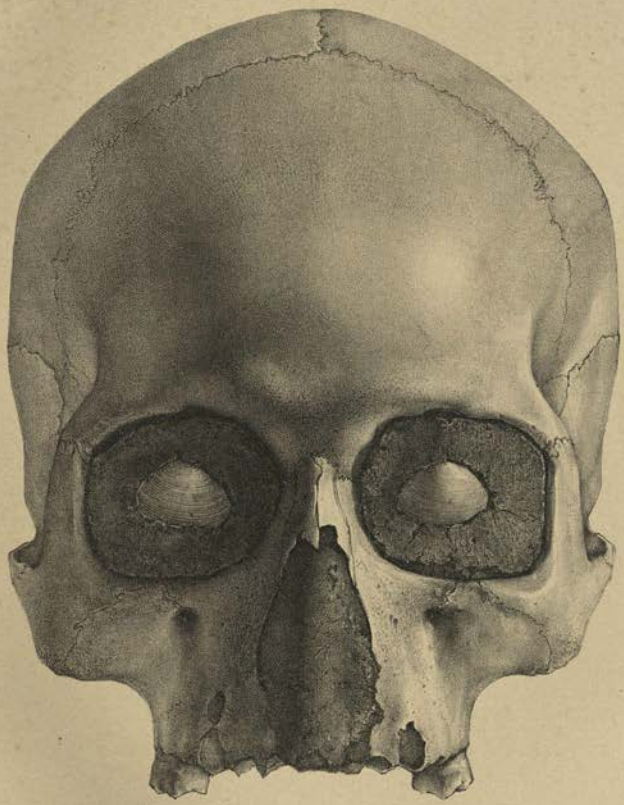
AUSTRALIANS.

PLATE III.

PLATE III.

Facial view of the artificially prepared skull of the Admiralty Islander D. (Table VIII.). In this skull a suture extended from the infraorbital foramen into the floor of the orbit. Natural size.



W. Turner del.

P. Huth, Lith.r Edin.r

ADMIRALTY ISLANDER.

PLATE IV.

PLATE IV.

Fig. 1. Profile view of the skull of the Admiralty Islander A. (Table VIII.); one-half natural size.

Fig. 2. Facial view of the skull of the Admiralty Islander C. (Table VIII.); one-half natural size.

Fig. 3. Nasal region of the Admiralty Islander in which the nasal bones were apparently absent E. (Table VIII.). In this skull a suture extended from the infra-orbital foramen into the floor of the orbit. Natural size.

Fig. 4. Profile view of the skull of the Admiralty Islander K. (Table VIII.), showing the division of the right parietal bone into an upper and a lower portion.

Fig. 4.

Fig. 3.

Fig. 1.

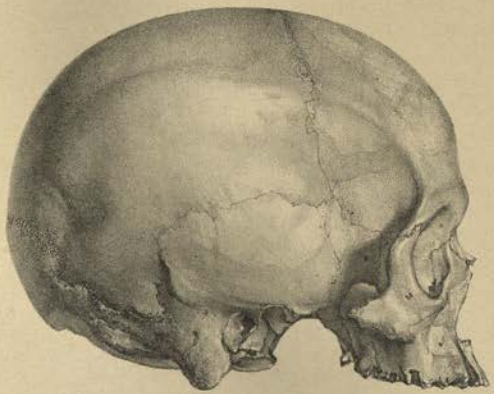


Fig. 2.

W. Turner dir.

F. Huth, Lith. Edin.

ADMIRALTY ISLANDERS.

PLATE V.

PLATE V.

Fig. 1. Occipital view of the skull of the Admiralty Islander A. (Table VIII.).

Fig. 2. Vertex view of the same skull.

Fig. 3. Profile view of the skull of a Hawaian from Waimea Plains (Table IX.).

Fig. 4. Facial view of the same skull.

All the Figures in this Plate are one-half natural size.

Fig. 4.

Fig. 3.

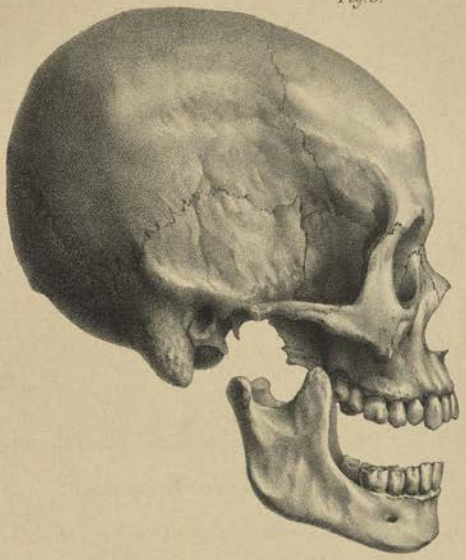


Fig. 2.

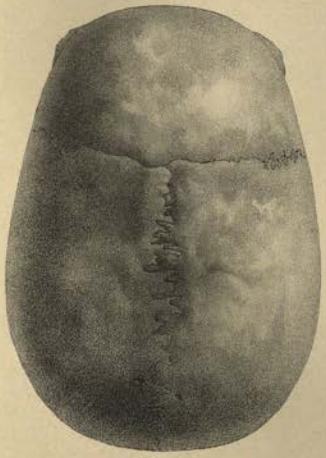
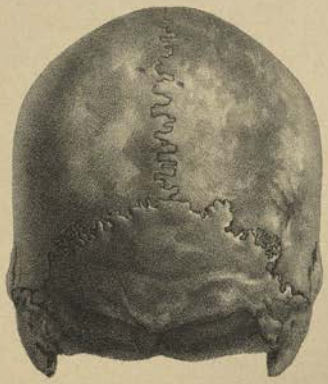


Fig. 1.



W. Turner dir.

J. Roth, Lith. Edin.

FIGS. 1 & 2, ADMIRALTY ISLANDER. FIGS. 3 & 4, SANDWICH ISLANDER, (Waimea)

PLATE VI.

PLATE VI

oc., basi-occipital radius.
l., basi-lambdoidal radius.
p., perpendicular radius.
br., basi-bregmatic radius.
g., basi-glabellar radius.

s., plane of dorsum sellæ.
os., basi-occipito-sphenoid axis.
cr., axis of cribriform plate.
sm., spheno-maxillary line.

Mesial antero-posterior sections of the following crania:—

Fig. 1. Bushman from Umzimkulu (Table I.).

Fig. 2. Fuegian D. (Table II.).

Fig. 3. Admiralty Islander A. (Table VIII.).

Fig. 4. Oahuan D. (Table XI.).

Fig. 5. Hawaian A. (Table IX.).

All the Figures in this Plate are one-half natural size.

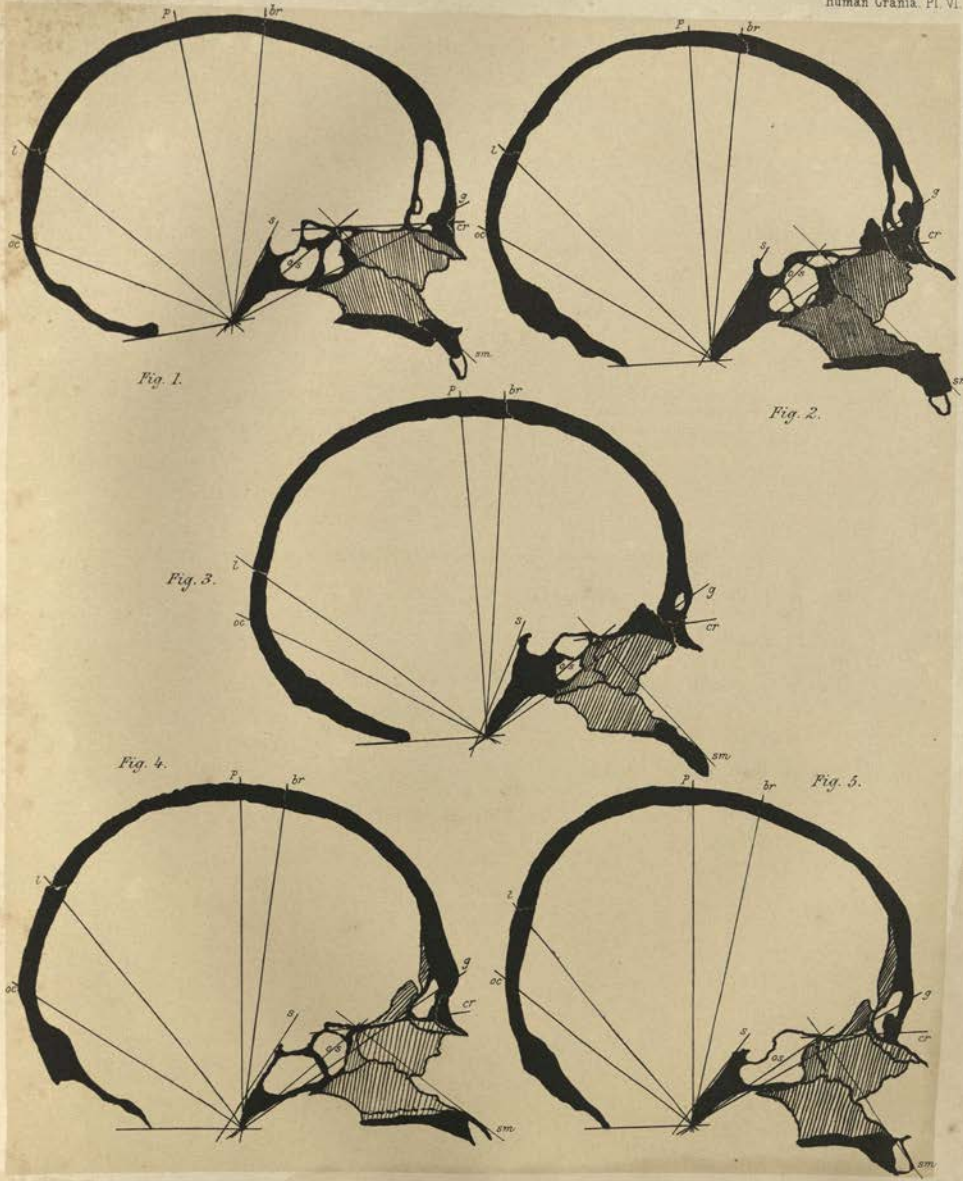


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

W Turner del.

F Huth, Lithº Edinr

Fig. 1, BUSHMAN. Fig. 2, FUEGIAN. Fig. 3, ADMIRALTY ISLANDER.
Fig. 4, OAHUAN. Fig. 5, HAWAIAN.

PLATE VII.

PLATE VII.

oc., basi-occipital radius.
l., basi-lambdoidal radius.
p., perpendicular radius.
br., basi-bregmatic radius.
g., basi-glabellar radius.

s., plane of dorsum sellæ.
os., basi-occipito-sphenoid axis.
cr., axis of cribriform plate.
sm., spheno-maxillary line.

Similar sections of the following crania:—

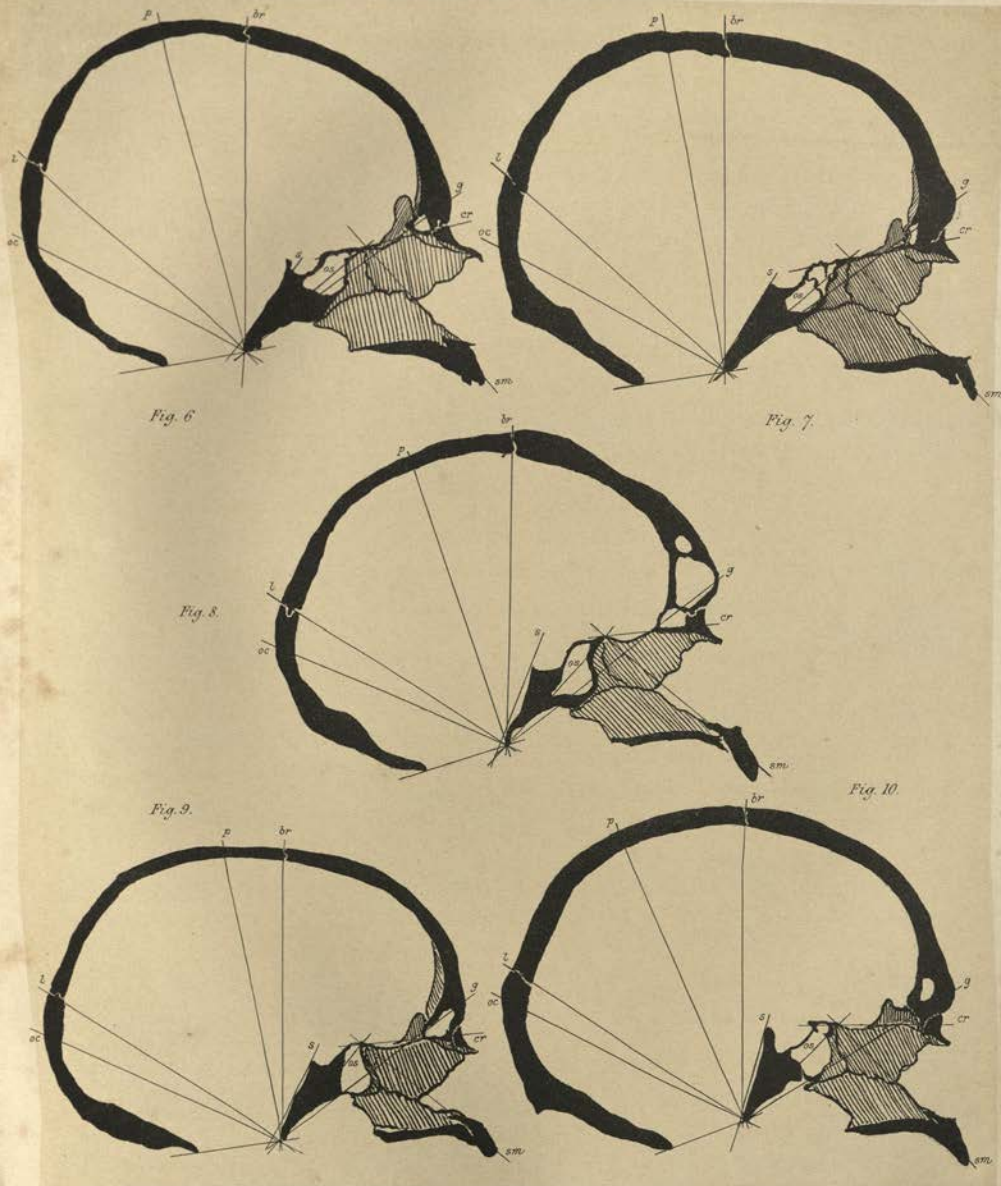
Fig. 6. Waikato, New Zealander (Table XIV.).

Fig. 7. Chatham Islander (Table XIII.).

Fig. 8. Australian.

Fig. 9. Australian from Gipps Land (Table V.).

Fig. 10. Australian from Queensland (Table III.).



W. Turner del.

F. Huth, Lith^r Edin^r

Fig 6, NEW ZEALANDER. Fig 7, CHATHAM ISLANDER. Fig. 8, AUSTRALIAN.
Fig. 9, GIPPS LAND, AUSTRALIAN. Fig. 10, QUEENSLAND, AUSTRALIAN.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the POLYZOA collected by H.M.S. Challenger during the years 1873–76. By GEORGE BUSK, F.R.S., V.P.L.S., &c.

PART I.—THE CHEILOSTOMATA.

INTRODUCTION.

WHEN at Sir Wyville Thomson's request I undertook the description of the Polyzoa collected on the Voyage of the Challenger, I had formed no idea of the extent of the task I had imposed on myself, nor of the time, amidst other engagements, that would be required for its due execution, which I can only regret has been so protracted.

One result of the delay in publication has necessarily been to diminish to a considerable extent the originality of my Report, as regards the introduction of new species.

More especially during the last eight or nine years the number of workers in all parts of the world in the subject of the Marine Polyzoa has been much increased, with, of course, a corresponding addition to the number of new species. As amongst these there are many that I had previously noticed in the Challenger Collection, and to which, in the progress of my work, I had assigned names, which were unfortunately appended to the Plates as they were printed off, it became necessary to make the numerous changes of nomenclature which will be noticed in the Explanations of the Plates.

I have endeavoured as much as possible to keep pace with the rapid additions of new species for which science has been indebted to various observers, amongst whom more particularly should be mentioned the Rev. T. Hincks, Mr. P. H. Macgillivray, Mr. J. B. Wilson, and Mr. Goldstein and others. But with the utmost desire to do full justice to priority of publication, numerous omissions will, I fear, be observed, in extenuation of which I can only plead either complete oversight or the circumstance that in many cases I have not found it possible to identify with certainty the species intended from the published figures and descriptions, in the absence of specimens. This remark applies more especially to certain more or less well-marked natural groups or families in which the common characters, so to speak, are so strongly marked as in some cases to mask the more minute specific features. Amongst these groups may be noticed more particularly the Reteporidæ, Salicornariadæ, Celleporidæ, and Adeoneæ, amongst which, as well as in many other of the provisional or artificial escharan genera, are numerous forms which cannot be distinguished with certainty in the absence of the characters afforded by the chitinous parts.

The number of species of CHEILOSTOMATA contained in the Challenger Collection, so far as I have been able to determine them, is about two hundred and eighty-six, of which, at the time when the collection came into my hands seven years ago, no less than one hundred and eighty appeared to be new, or were unrecognisable by me.

Nor is this large proportion of new species much to be wondered at, seeing the peculiar conditions, especially as to depth of water and distance from land, under which the majority of the Challenger's dredgings and trawlings were made.

Though more or less visible throughout the greater part of the collection, the difference between a collection of Polyzoa made in deep water or at a distance from shore, and one made in the same geographical region near the shore, or in shallow water, is in no case so strongly exemplified as in that of the almost exclusively Australian genus *Catenicella*.

On the voyage of H.M.S. "Rattlesnake," employed in a surveying expedition on the coast of Australia and the neighbouring islands, the collections were of course chiefly made near the shore or in soundings of a moderate depth. On that expedition Mr. J. Macgillivray collected no less than seventeen or eighteen species of the genus, to which, either from Australia or New Zealand, about as many more have since been added, so that the number of known species of *Catenicella* living in comparatively shallow water may be roughly estimated at between thirty and forty; all with two or three exceptions peculiar to the Australian region.

Belonging to this genus the Challenger Collection contains eight species, seven of which only were procured in the Australian region at depths varying from 30 to 120 fathoms, and from closely contiguous Stations. An eighth, and the only new species, was obtained in the South Atlantic region off the coast of Brazil, where the depth is recorded as 350 fathoms.

Classification.

As to the scheme of classification followed in this Report, and set forth in the sub joined Table on pages xxii, xxiii, it is scarcely necessary to remark that it has no pretension to be regarded as more than a convenient, and, to a considerable degree, artificial arrangement, like all others that have been proposed. For although many of the family groups may in some measure be regarded as expressing natural alliances, many of them, more especially in the Subdivision C., or Escharina, can only be considered as artificial, and as such they must perhaps remain until we are better acquainted with the true significance of the minute parts or organs upon which the distinctive characters are in many cases founded. Nor at present, perhaps, are we in a position fully to appreciate the relative value of the *zoœcial* as compared with the *zoarial* characters, which of late it appears to be the fashion, unduly as I think, to depreciate; the individuality of the zoarium as a continuous whole or entity having been too much overlooked in the almost exclusive consideration of its component parts or segments.

Nevertheless, in order to place myself as far as possible in accord with modern views, I have, in the heterogeneous Family Escharidæ more especially, adopted partially the nomenclature proposed by Mr. Hincks and Prof. Smitt, but in doing this I have found it impossible to avoid a certain amount of the confusion necessarily incidental to an attempt to graft a new system upon an old one, based on a different set of characters.

Geographical and Bathymetrical Distribution.

With respect to the geographical distribution of the species enumerated in the Report, I have thought it convenient to divide the oceans traversed by the Challenger into seven regions, distinguished by the letters A, B, C, D, E, F, G; three being to the north and four to the south of the equator, each including 90° of longitude, as shown in the accompanying map, in which also are marked the Stations from which any Polyzoa were obtained.

A. North Atlantic Region, between the parallels of 70° W. and 20° E.[1]
B. South Atlantic Region, from 70° W. to 20° E.
C. South Indian or Kerguelen Region, from 20° to 110° E.
D. Australian Region, from 110° E. to 160° W. and S.
E. Philippine or Japanese Region, from 110° E. to 160° W. and N.
F. North Pacific Region, from 160° W. to the west coast of North America.
G. South Pacific, from 160° to 70° W.

In the following List the Stations in each geographical region are arranged in bathymetrical order, beginning with those of the greatest depth. To the names of the

[1] One Station, viz., 44, is 71° 40′ W.

species procured at each Station a reference is added, by corresponding letters, to the other regions in which the same species occurred, so that its geographical distribution might be seen at a glance, and at the same time it will be observed that the extent of geographical distribution is to a considerable degree correlative with the bathymetrical, the wider distribution being in most instances coincident with the shallower depths; though to this there are some striking exceptions.

A.—NORTH ATLANTIC REGION.

STATION 64, lat. 35° 35′ N., long. 50° 27′ W.; 2750 fathoms (?); red clay.

Farciminaria delicatissima.

STATION 101, lat. 5° 48′ N., long. 14° 20′ W.; 2500 fathoms; blue mud.

Bugula reticulata, var. *unicornis.*

STATION 104, lat. 2° 25′ N., long. 20° 1′ W.; 2500 fathoms; Globigerina ooze.

Bugula reticulata, var. *unicornis.*

STATION 89, lat. 22° 18′ N., long. 22° 2′ W.; 2400 fathoms; Globigerina ooze.

Bugula mirabilis. | *Farciminaria delicatissima.*

STATION 68, lat. 38° 3′ N., long. 39° 19′ W.; 2175 fathoms; Globigerina ooze.

Farciminaria delicatissima. | *Bugula reticulata*, var. *unicornis.*
Bifaxaria reticulata.

STATION 14, lat. 21° 1′ N., long. 46° 29′ W.; 1950 fathoms; Globigerina ooze.

Farciminaria delicatissima.

STATION 13, lat. 21° 38′ N., long. 44° 39′ W.; 1900 fathoms; Globigerina ooze.

Farciminaria delicatissima. | *Salicornaria magnifica*, B, C.
Bifaxaria reticulata. | *Tessaradoma boreale.*

STATION 106, lat. 1° 47′ N., long. 24° 26′ W.; 1850 fathoms; Globigerina ooze.

Bugula reticulata, var. *unicornis.* | *Farciminaria delicatissima.*

STATION 44, lat. 37° 25′ N., long. 71° 40′ W.; 1700 fathoms; blue mud.

Canda simplex.

STATION 70, lat. 38° 25′ N., long. 35° 50′ W.; 1675 fathoms; Globigerina ooze.

Menipea clausa. | *Farciminaria gracilis*, B.

Bifaxaria minuta.

STATION 87, lat. 25° 49′ N., long. 20° 12′ W.; 1675 fathoms; rock.

Nellia simplex.

STATION 3, lat. 25° 45′ N., long. 20° 14′ W.; 1525 fathoms; hard ground.

Bugula leontodon.

STATION VI., lat. 36° 23′ N., long. 11° 18′ W.; 1525 fathoms; Globigerina ooze.

Kinetoskias cyathus, B.

CAPE VERDE ISLANDS, lat. 17° 12′ N., long. 24° 55′ W.; 1070 to 1150 fathoms; volcanic mud.

Scrupocellaria macandrei.

STATION 76, lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; Pteropod ooze.

Cellularia biloba. | *Carbasea pedunculata.*

STATION 23, lat. 18° 24′ N., long. 63° 28′ W., off Sombrero Islands; 450 fathoms; Pteropod ooze.

Brettia cornigera. | *Pasythea eburnea*, B.

Bugula versicolor, B. | *Farciminaria atlantica.*

Tessaradoma boreale.

STATION 75, lat. 38° 38′ N., long. 28° 28′ W.; 450 fathoms; volcanic mud.

Hippothoa divaricata, C. | *Retepora atlantica.*

Carbasea pedunculata. | *Cribrilina radiata.*

Membranipora albida, D. | *Flustramorpha hastigera.*

Membranipora galeata, var. *multifida*, B. | *Smittia oratavensis.*

Micropora coriacea. | *Mucronella canalifera.*

Retepora imperati. | *Adeonella distoma.*

Cellepora ansata.

Cellepora ovalis.

STATION 24, lat. 18° 38′ N., long. 65° 5′ W., off Culebra Island; 390 fathoms; Pteropod ooze.

Pasythea eburnea, B. | *Farciminaria atlantica.*

CAPE VERDE ISLANDS, 100 to 120 fathoms.

Retepora imperati. | *Smittia jacobensis.*
Porella lævis, var. *subcompressa.*

STATION 48, lat. 43° 4′ N., long. 64° 5′ W.; 51 fathoms; rock.

Escharo elegantula. | *Cellepora canaliculata.*

STATION 36, lat. 32° 7′ N., long. 65° 4′ W., off Bermuda; 30 fathoms; coral.

Ætea anguina, C, D, G. | *Bugula neritina.*

CAPE VERDE ISLANDS, 10 fathoms.

Diachoris hirtissima. | *Cupularia owenii.*

STATION 109, lat. 0° 55′ N., long. 29° 22′ W., off St. Paul's Rocks; shallow water.

Catenaria diaphana. | *Scrupocellaria macandrei.*
Tubucellaria opuntioides.

B.—SOUTH ATLANTIC REGION.

STATION 325, lat. 36° 44′ S., long. 46° 16′ W.; 2650 fathoms; blue mud.

Cellularia crateriformis. | *Kinetoskias cyathus*, A.
Farciminaria magna, C.

STATION 332, lat. 37° 29′ S., long. 27° 31′ W.; 2200 fathoms; Globigerina ooze.

Bicellaria navicularis. | *Bugula margaritifera.*

STATION 323, lat. 35° 39′ S., long. 50° 47′ W.; 1900 fathoms; blue mud.

Cellularia crateriformis. | *Farciminaria cribraria.*
Bugula margaritifera. | *Farciminaria magna*, var. *armata.*
Salicornaria magnifica, A, C.

STATION 320, lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; green sand.

Caberea crassimarginata.
Bugula reticulata, C, G.
Ichthyaria oculata.
Membranipora galeata, var. *erecta*, A.
Foveolaria elliptica, D.
Foveolaria falcifera.
Vincularia labiata.
Bifaxaria denticulata.
Salicornaria dubia.
Melicerita atlantica.
Melicerita dubia.
Retepora magellensis.
Turritigera stellata.
Cribrilina latimarginata.
Smittia smittiana.
Myriozoum immersum.
Myriozoum simplex.
Cellepora rudis.

STATION 135, lat. 37° 1′ S., long. 12° 19′ W., Tristan da Cunha Islands; 360 fathoms; volcanic sand.

Ætea anguina, A, D, G.
Hippothoa divaricata, A.
Catenicella elegans, D.
Scrupocellaria pilosa.
Caberea darwinii, C.
Membranipora crassimarginata, var. *incrustans.*
Micropora uncifera.
Micropora coriacea, A.
Cribrilina radiata, A.
Microporella ciliata.
Microporella malusii.
Lepralia incisa.
Chorizopora hyalina, var. *bougainvillei*, C.
Aspidostoma giganteum.
Schizoporella auriculata, var. *alba.*
Schizoporella circinata.
Haswellia auriculata.
Adeonella atlantica.
Cellepora tubulosa.

STATION 122, lat. 9° 5′ S., long. 34° 50′ W., off Barra Grande, Brazil; 350 fathoms; red mud.

Pasythea eburnea, A.
Catenicella saeculata.
Catenicella elegans, D.
Bicellaria naviculoris.
Bugula versicolor, A.
Kinetoskias pocillum, G.
Farciminaria brasiliensis.
Farciminaria gracilis, A.
Bifaxaria submucronata.
Bifaxaria corrugata.
Salicornaria magnifica, A, C.
Mucronella castanea.
Adeonella distoma, var. *imperforata.*
Cellepora aspera.

STATION 142, lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; green sand.

Menipea marionensis, C.
Caberea darwinii, C.
Retepora tessellata, var. *pubens*.
Turritigera stellata.
Flustramorpha marginata, C.
Schizoporella nivea.
Schizoporella elegans.
Gephyrophora polymorpha.
Haswellia auriculata.
Adeonella regularis.
Cellepora cylindriformis.

STATION 314, lat. 51° 35′ S., long. 65° 39′ W.; 70 fathoms; sand.

Menipea benemunita, C, G.
Menipea aculeata, G.
Menipea flagellifera, C.
Ichthyaria oculata.
Carbasea elegans, D.
Salicornaria variabilis, C, G.
Salicornaria tenuirostris.
Cellepora bicornis, C.

STATION 313, lat. 52° 20′ S., long. 67° 39′ W.; 55 fathoms; sand.

Menipea benemunita, C, G.
Menipea flagellifera, C.
Cribrilina monoceros, C, D, F, G.
Smittia marsupialis, F.
Cellepora bicornis, C.

OFF BAHIA; 10 to 40 fathoms.

Nellia oculata, C, D, E.
Bicellaria glabra.
Smittia tenuis.
Mucronella castanea.
Gemellipora glabra.
Cellepora imbellis.
Cellepora mamillata, var. *atlantica*, C.
Cupularia monotrema.

SIMON'S BAY, Cape of Good Hope; 18 fathoms.

Menipea flabellum.
Menipea triseriata.
Menipea cirrata.
Membranipora galeata, var. *multifida*, A.
Amphiblestrum imbricatum.
Amphiblestrum capense.
Foveolaria tubigera.
Onchoporella bombycina.
Retepora tessellata.
Retepora tessellata, var. *cæspitosa*.
Retepora lata.
Cribrilina labiosa, var. *fragilis*.
Chorizopora brongniartii.
Mucronella contorta.
Mucronella tricuspis, C.
Schizoporella tenuis, F.
Gemellipora cribritheca.
Cellepora simonensis.
Cellepora conica.

STATION 315, lat. 51° 40′ S., long. 57° 50′ W.; 12 fathoms; sand and gravel.

Menipea benemunita, C, G.
Menipea aculeata, G.
Caberea minima.
Carbasea ovoidea, C, G.
Diachoris magellanica, D.
Diachoris costata.
Salicornaria malvinensis, C, D, G.
Cribrilina monoceros, C, D, F, G.
Microporella malusii.
Lepralia margaritifera.
Lepralia marsupium.
Chorizopora hyalina, var. *bougainvillei*, C.
Smittia stigmatophora.
Mucronella tricuspis, C.
Cellepora eatonensis, C, G.

PORT WILLIAM, Falkland Islands; 5 to 10 fathoms.

Carbasea ovoidea, C, G. | *Salicornaria malvinensis*, C, D, G.

C.—SOUTH INDIAN OR KERGUELEN REGION.

STATION 156, lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; Diatom ooze.

Bicellaria infundibulata.

STATION 157, lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; Diatom ooze.

Bugula bicornis. | *Salicornaria magnifica*, A, B.
Onchopora sinclairii.

STATION 153, lat. 65° 42′ S., long. 79° 49′ E.; 1675 fathoms; blue mud.

Farciminaria magna, B.

STATION 147, lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; Diatom ooze.

Bicellaria infundibulata. | *Bugula reticulata*, B, G.
Foveolaria orbicularis.

STATION 148, lat. 46° 47′ S., long. 51° 37′ E., off Possession Island; 210 fathoms; hard ground, gravel, shells.

Nellia oculata, B, D, E.
Caberea darwinii, B.
Retepora gigantea.
Retepora cavernosa.
Reteporella myriozoides.
Escharoides occlusa, D, E.
Smittia graciosa.
Mucronella ventricosa, var. *multispinata.*
Myriozoum marionense.
Cellepora vagans.
Cellepora mamillata, var. *atlantica*, B.
Schizoporella elegans, B.

STATION 150, lat. 52° 4′ S., 71° 22′ E.; 150 fathoms; coarse gravel.

Bicellaria peetogemma.
Membranipora galeata, var. *furcata.*
Onchopora sinclairii.
Cellepora bicornis, B.

STATION 145, lat. 46° 43′ S., long. 38° 4′ E.; 140 fathoms; volcanic sand.

Bicellaria pectogemma.
Farciminaria hexagona.

PRINCE EDWARD ISLAND; 80 to 150 fathoms.

Caberea darwinii, B.
Bugula sinuosa.
Carbasea ovoidea, B, G.
Vincularia gothica.
Electra cylindracea.
Salicornaria clavata, D, G.
Smittia marionensis.
Mucronella rostrigera.
Mucronella tricuspis, B.
Mucronella ventricosa, var. *multispinata.*
Myriozoum marionense.
Cellepora bicornis, B.

STATION 151, lat. 52° 59′ S., long. 73° 33′ E., off Heard Island; 75 fathoms; volcanic mud.

Hippothoa flagellum.
Catenaria attenuata.
Cellularia quadrata.
Nellia oculata, B, D, E.
Bicellaria pectogemma.
Bugula longissima.
Diachoris magellanica, var. *distans.*
Membranipora crassimarginata, var. *erecta*, D.
Vincularia gothica, var. *granulata.*
Salicornaria clavata, D, G.
Onchopora sinclairii.
Reteporella flabellata.
Cribrilina philomela, var. *adnata.*
Escharoides verruculata.
Schizoporella triangula, D.
Myriozoum marionense.
Cellepora albirostris.

STATION 144A, lat. 46° 48′ N., long. 37° 49′ E., Marion Island; 69 fathoms; volcanic sand.

Menipea flagellifera, B.
Menipea marionensis, B.
Caberea darwinii, B.
Carbasea ovoidea, B, G.
Membranipora galeata, var. *furcata.*
Salicornaria malvinensis, B, D, G.
Cribrilina philomela.
Cribrilina philomela, var. *adnata.*
Cribrilina monoceros, B, D, F, G.
Flustramorpha marginata, B.
Smittia jacobensis, A.
Schizoporella marsupifera, D.
Myriozoum marionense.
Cellepora pustulata, D.
Cellepora bicornis, B.

STATION 149, lat. 49° 8′ S., long. 70° 12′ E.; Kerguelen Islands; 20 fathoms; volcanic mud.

Cellularia quadrata.
Cellularia elongata.
Menipea benemunita, B, G.
Menipea flagellifera, B.
Caberea darwinii, B.
Bugula longissima.
Flustra crassa.
Carbasea ovoidea, B, G.
Diachoris inermis.
Membranipora galeata.
Amphiblestrum cristatum.
Salicornaria clavata, D, G.
Salicornaria variabilis, B, G.
Salicornaria malvinensis, B, D, G.
Onchopora sinclairii.
Chorizopora hyalina, var. *bougainvillei*, B.
Smittia marionensis.
Cellepora eatonensis, B, G.

D.—AUSTRALIAN REGION.

STATION 160, lat. 42° 42′ S., long. 134° 10′ E.; 2600 fathoms; red clay.

Cellepora solida.

STATION 176, lat. 18° 30′ S., long. 173° 52′ E.; 1450 fathoms; Globigerina ooze.

Salicornaria malvinensis, B, C, G.
Retepora margaritacea.

STATION 195, 4° 21′ S., long. 129° 7′ E.; 1425 fathoms; blue mud.

Cellularia cirrata.
Farciminaria hexagona, C.

STATION 196, lat. 0° 48′ S., long. 126° 58′ E.; 825 fathoms; hard ground.

Brettia australis.
Bicellaria bella.
Bicellaria moluccensis.
Bicellaria macilenta.
Farciminaria hexagona, C.
Flustra biseriata, G.
Carbasea dissimilis.
Bifaxaria papillata.
Siphonicytara serrulata.

STATION 170, lat. 29° 55′ S., long. 178° 14′ W., off Kermadec Islands; 520 fathoms; volcanic mud.

Carbasea moseleyi.

STATION 167, lat. 39° 32′ S., long. 171° 48′ E.; 150 fathoms; blue mud.

Caberea rostrata.
Schizoporella marsupifera, C.
Cellepora pustulata, C.

STATION 163A, lat. 36° 59′ S., long. 150° 20′ E., off Twofold Bay; 150 fathoms; green mud.

Eucratea chelata.
Catenicella ventricosa.
Catenicella hastata.
Catenicella plagiostoma.
Catenicella elegans, B.
Didymia simplex.
Dimetopia cornuta.
Flustra denticulata.
Carbasea dissimilis.
Membranipora spinosa.
Amphiblestrum umbonatum.
Calymmophora lucida.
Salicornaria divaricata.
Salicornaria bicornis.
Tubucellaria hirsuta.
Smittia transversa.
Adeona appendiculata.

STATION 190, lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; green mud.

Nellia oculata, B, C, E.
Caberea lata.
Carbasea cribriformis.
Retepora columnifera.
Retepora delicatula.
Eschara gracilis.
Mucronella bisinuata.
Haswellia australiensis.
Adeonella intricaria.

STATION 162, lat. 39° 10′ S., long. 146° 37′ E., Bass Strait; 38 fathoms; sand and shells.

Ætea anguina, A, C, G.
Catenicella hastata.
Canda arachnoides.
Flustra membraniporides.
Carbasea dissimilis.
Carbasea elegans, B.
Carbasea pisciformis.
Diachoris crotali.
Membranipora crassimarginata, var. *erecta*, C.
Amphiblestrum cervicorne.
Foveolaria elliptica, B.
Caleschara denticulata, var. *tenuis.*
Salicornaria clavata, C, G.
Salicornaria simplex.
Retepora crassa.
Retepora phœnicea.
Eschara gracilis.
Schizoporella triangula, C.
Cellepora hastigera.
Cellepora columnaris.
Cellepora bidenticulata, var. *subæqualis.*

STATION 163B, lat. 33° 51′ S., long. 151° 22′ E., off Port Jackson; 35 fathoms; hard ground.

Catenicella plagiostoma.
Catenicella umbonata.
Catenicella pulchella.
Flustra membraniporides.
Salicornaria clavata, C, G.
Cribrilina monoceros, B, C, F, G.
Lepralia tuberosa.
Schizoporella jacksoniensis.
Cellepora tuberculata.
Cellepora jacksoniensis.
Cellepora apiculata.
Cellepora bidenticulata.

STATION 161, lat. 38° 22′ S., long. 144° 36′ E., off Port Philip; 33 fathoms; sand.

Ætea anguina, A, C, G.
Catenicella hastata.
Catenicella cribraria.
Cellularia cuspidata.
Emma crystallina.
Caberea rudis.
Carbasea dissimilis.
Retepora crassa.
Retepora victoriensis.
Mucronella pyriformis.
Mucronella simplicissima.
Schizoporella cecilii.
Cellepora bilabiata.
Lunularia capulus.

STATION 188, lat. 9° 59′ S., 139° 42′ E.; 28 fathoms; green mud.

Catenicella elegans, B.
Scrupocellaria ciliata.
Nellia oculata, B, C, E.
Carbasea cribriformis.

STATION 172, lat. 20° 58′ S., long. 175° 9′ W., off Nukalofa, Tongatabu; 18 fathoms; coral mud.

Membranipora albida, A.
Retepora apiculata.
Retepora producta, E.
Mucronella quadrata.

PORT JACKSON; 2 to 10 fathoms; mud.

Diachoris magellanica, B.
Retepora jacksoniensis.

STATION 186, lat. 10° 30′ S., long. 142° 18′ E., off Cape York; 8 fathoms; coral mud.

Chlidonia cordieri.
Caberea lata.
Carbasea cribriformis.
Salicornaria gracilis.
Retepora hirsuta.
Retepora tubulata.
Lepralia celleporoides.
Lepralia dorsiporosa.
Escharoides occlusa, C, E.
Haswellia australiensis.
Adeonella pectinata.
Cellepora discoidea.
Cellepora tridenticulata.
Cupularia guineensis.

ADMIRALTY ISLANDS.

Scrupocellaria securifera. | *Retepora simplex*, E.
Lepralia lonchœa.

E.—PHILIPPINE OR JAPANESE REGION.

STATION 241, lat. 35° 41′ N., long. 157° 42′ E.; 2300 fathoms; red clay.

Farciminaria pacifica.

STATION 214, lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms; blue mud.

Bifaxaria lævis.

STATION 201, lat. 70° 3′ N., long. 121° 48′ E.; 82 fathoms; stones and gravel.

Adeonella platalea.

COBIE, JAPAN; 8 to 50 fathoms.

Retepora victoriensis, var. *japonica.* | *Lepralia japonica.*

STATION 208, lat. 11° 37′ N., long. 123° 31′ E.; 18 fathoms; blue mud.

Nellia oculata, B, C, D. | *Retepora mucronata.*
Amphiblestrum papillatum. | *Microporella personata.*
Lepralia feegeensis.

STATION 212, lat. 6° 54′ N., long. 122° 18′ E.; 10 fathoms; sand.

Retepora philippinensis.

SAMBOANGAN; 10 fathoms.

Biflustra savartii. | *Escharoides occlusa*, C, D.
Retepora producta, D. | *Adeonella polymorpha.*
Retepora simplex, D. | *Cellepora samboangensis.*

F.—NORTH PACIFIC REGION.

STATION 253, lat. 38° 9′ N., long. 156° 25′ W.; 3125 fathoms; red clay.

Bifaxaria abyssicola.
Cribrilina monoceros, B, C, D, G.
Bugula johnstoniæ.[1]
Phylactella, sp.?

OFF HONORURU, Sandwich Islands; 20–40 fathoms.

Scrupocellaria ornithorhynchus.
Steganoporella magnilabris.
Retepora denticulata.
Retepora contortuplicata.
Chorizopora honolulensis.
Smittia marsupialis, B.
Mucronella delicatula.
Mucronella magnifica.
Schizoporella furcata.
Schizoporella tenuis.
Myriozoum honolulense.
Cellepora honolulensis.
Cellepora polymorpha.
Cellepora vagans, C.

G.—SOUTH PACIFIC REGION.

STATION 299, lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; blue mud.

Menipea pateriformis.
Bugula reticulata, B, C.
Kinetoskias pocillum, B.
Flustra biseriata, D.

STATION 280, lat. 18° 40′ S., long. 149° 52′ W.; 1940 fathoms; Globigerina ooze.

Catenaria bicornis.

STATION 303, lat. 45° 31′ S., long. 78° 9′ W.; 1325 fathoms; blue mud.

Menipea benemunita, B, C.
Menipea aculeata, B.
Carbasea ovoidea, B, C.
Cribrilina monoceros, B, C, D, F.
Cellepora eatonensis, B, C.

STATION 304, lat. 46° 53′ S., long. 75° 12′ W.; 45 fathoms; green sand.

Ætea anguina, A, C, D.
Salicornaria clavata, C, D.
Salicornaria variabilis, B, C.
Salicornaria malvinensis, B, C, D.
Cellepora signata.

STATION 312, lat. 53° 37′ S., long. 70° 56′ W.; 9 fathoms; blue mud.

Carbasea ovoidea, B, C.
Schizoporella longispinata.

[1] This and the following species were too fragmentary to permit of complete identification, and have therefore not been included in the text.

Explanation of Terms.

Subjoined are a few notes respecting some of the terms employed in this Report, which may perhaps require explanation either as new or as employed in a particular sense.

I. With respect to the characters presented by the Zoarium, I have employed the word *dimorphous* to express that it may be both erect or free, or decurrent and incrusting, and more or less closely attached.

II. With regard to the Zoœcia—

A. The surface may be

1. Smooth.
2. Polished.
3. Granular.
4. Verrucose.
5. Rugose.
6. Pitted.
7. Punctulate, minutely porous.
8. Punctate, with larger perforations.
9. Reticulate.

B. The orifice may be

1. Orbicular.
2. Elliptical.
3. Semiorbicular.
4. Crescentic.
5. Coarctate.
6. Trifoliate.
7. Clithridiate (keyhole-shaped).

C. The lower border may be

1. Entire, sinuous, or straight.
2. Mucronate.
3. Emarginate.
4. Dentate.
5. Bidenticulate.
6. Incised.

D. The peristome may be

1. Thin or thick.
2. Elevated, produced or level.
3. Armed with oral spines, either rigid or articulated
4. Unarmed.

III. Special pores may be present on the front of the zoœcia, and are

1. Lunate—crescentic and usually fimbriated.
2. Simple—circular and either (*a*) *suboral* or *labial*, formed by the constriction of a notch in the lower lip; or (*b*) *central*, independent of the orifice.

IV. The Oœcia may be

1. Erect or recumbent.
2. Front entire, fissured, or punctured.
3. Cucullate—when the front is widely deficient.
4. Stigmate, with a trifoliate or circular bordered mark or space (stigma) in front.

V. Special Organs.—Under this head are included all forms of avicularian and vibracular organs.

A. Avicularia, may be

1. As to form—
   (*a*) Pedunculate and usually articulate.
   (*b*) Sessile.
   (*c*) Immersed.

2. As to function—

(*a*) Prehensile—when the mandible, beak, and muscles are adapted for prehensile purposes.

(*b*) Retentive—when the mandible is thin, membranous, and weak, and adapted merely to serve as a lid to the cup or receptacle.

3. As to position—

(*a*) Vicarious—when they represent or replace an ordinary zoœcium.

(*b*) Adventitious—when either attached to some part or other of a zoœcium or interspersed among the zoœcia.

B. Vibracula, of which two varieties may be distinguished—

1. Simple—consisting of a basal cup, without a beak, to which the *seta* or *flagellum* is articulated, usually by a double joint, admitting of motion in only one plane.
2. Compound—in which the seta is continuous with or articulated to a basal mandibular portion, and the cup or receptacle has a more or less distinct beak.

VI. CHITINOUS ELEMENTS.—As will be seen in the Report, I have in several families largely resorted to the chitinous elements of the skeleton for diagnostic characters, for which purpose it is in many cases impossible to over-rate the value of these parts, as I have attempted partially to show in another place,[1] and further study has only convinced me that their importance extends far beyond the mere distinction of genera and species. But to render this manifest it would be necessary to embrace many forms besides those contained in the Challenger collection, and I am not as yet prepared to go fully into the subject, even were this the proper place.

The chitinous elements here principally intended, are the so-termed *opercula* or *oral valves* and the chitinous parts of the avicularia and vibracula, that is to say, the *mandibles* and *setæ* or *flagella*.

A. Opercula.—Although there are one or two forms which must be ranged under the CHEILOSTOMATA, in which the existence of a distinct operculum or articulated lid to the orifice cannot be detected, such an appendage in some form or another may be regarded as an all but universal characteristic of the sub-order.

The infinite variety in form and structure, and mode of muscular attachment of the opercula, is very remarkable, as is also the constancy of the characters presented by them in the different species, genera, and families.

1. *Form.*—They are all more or less circular or semicircular in outline, with the lower border either straight or sinuated, or forming the segment of a smaller circle than the upper part, or by a further constriction produced in the middle into a narrower or

[1] On the Use to be made of the Chitinous Organs in the Cheilostomata in the Diagnosis of Species, &c., *Journ. Linn. Soc. Lond.* (Zool.), vol. xv. p. 357, 1881.

wider peduncular process, which usually, but not always, corresponds with a sinus or notch in the lower border of the orifice. The former kind may be termed "truncate" and the latter "pedunculate opercula."

2. *Structure.*—Some are composed of a continuous rigid, chitinous substance, but in the majority of cases the operculum is constituted of a thinner or stronger membrane, supported by a thickened chitinous border, to which are often added lateral rods or processes, or a more or less complicated framework; and they may be divided into;—

a. Complete.—In which the chitinous rim is continuous all round including the lower border.

b. Incomplete.—When the lower border remains membranous or is continuous, without distinct interruption, with the membranous endocyst of the zoœcium.

3. *Articulation of the Opercula.*—The mode in which the opercula are articulated varies very considerably. In those cases in which the zoœcia are completely calcified, as in the ESCHARINA generally, the operculum is directly articulated or attached to the sides of the orifice, usually at points near its inferior border, but sometimes higher up. The articulation is effected by an elastic fibrous ligament as it may be termed, which is generally inserted into a notch in the border of the operculum, but in some few cases into a projecting process, which corresponds to an incision in the border of the orifice on either side.

4. *Opercular Muscles.*—The motions of the operculum in the opening and closing of the orifice are effected by two pairs of muscles, occlusor and retractor, of which the former are the more important; these muscles are sometimes inserted with the intervention of a long slender tendon and sometimes immediately. The points and mode of attachment should be carefully noticed.

B. The other more important chitinous elements are the avicularian mandibles and vibracular setæ.

1. *Mandibles.*—These, like the opercula, exhibit very great variety of form, and not unfrequently several forms co-exist in one and the same species. But except in size, in which they often present greater differences than do the opercula, the characters of each particular type will be found remarkably constant.

Like the avicularia of which they form part, the mandibles may be divided into those adapted for a prehensile purpose, and those which form merely a movable lid to the cup or receptacle upon which they are seated.

In one division of the genus *Cellepora* (but only in those belonging to the southern hemisphere), in which the lower border of the orifice is straight and entire, the avicularian mandibles always present a slender process rising from the middle of the base, occasionally furnished with short hairs, to which I have applied the term *columella*.

a. The prehensile mandibles, though differing greatly in form, have certain characters in common which distinguish them from the other kind. In shape they vary from a simple semicircle or triangle to a more or less elongated, blunt, or acutely-pointed spear- or sword-shaped, formidable, weapon. They are formed of a strong chitinous frame with a base, by each extremity of which the mandible is articulated to the sides of its cup or receptacle, in which are lodged the occlusor and retractor muscles, &c. In this class of mandibles the sides towards the apex or upper border of the lower face are usually, but not always, finely toothed, and the apex, in the spear-shaped type especially, is very frequently furnished with an acute incurved point or fang. The interior of the chitinous frame is occupied by a membrane in which is almost always a large rounded or elongated *foramen,* above which are inserted the occlusor muscles, which usually constitute a distinct pair, but in one family (Adeoneæ) appear to be conjoined into a single band. By this arrangement it would seem that power rather than speed in the occlusion of the prehensile avicularium is provided for.

b. The retentive mandibles also present considerable variety of form, which may vary from a simple semicircle to all varieties of spatulate or duckbill-shape; usually rounded or obtuse but sometimes more or less bluntly pointed at the apex. They are generally simple, but occasionally bifid or trifid. Unlike the prehensile mandibles, they are constituted for the most part of a thin membranous expansion, supported only at the base or partially at the sides and lower part by a chitinous frame, by which also they are articulated. In this class of mandibles also the *foramen,* if present, is always close to the base, very near to which the weak occlusor muscles are inserted; we may conclude therefore that the retentive mandible is shut down with a sudden snap, or with great rapidity and but little force.

C. Besides the foregoing elements, which are almost universally present, others are met with which are limited to special groups; for instance, in the Family Salicornariadæ they consist of;—

1. A pair of slender curved rods imbedded in the ectocyst, one on each side of the orifice, and serving as *points d'appui* to the operculum; these I have termed *lateral trabeculæ,* but in some cases they are conjoined so as to form a complete or incomplete ring.

2. A very delicate chitinous, apparently tubular, filament contained in the areolar ridges, and constituting an "*areolar network*" continuous throughout each internode of the zoarium. (A somewhat similar network probably exists in some of the Selenariadæ.)

Very minute trabeculæ, somewhat similar to those of the Salicornariadæ, are found also in the genus *Steganoporella,* not on the sides but below the angles of the orifice.

The only other chitinous elements to which reference need be made are—

3. The so-termed *radical tubes* or *radicells.*

4. The different forms of clasping or connecting *tubular filaments.*

5. The *epitheca*, under which term is to be understood the more or less delicate cuticular investment, which, though in most cases very early removed by abrasion or otherwise, sometimes persists as a loosely attached epidermis, which may perhaps be regarded as homologically related to the chitinous wall of the radicell, and as representing the remains of the germinal membrane within which the entire zoarium is developed.

VII. MEASUREMENTS.—The magnified figures are nearly all enlarged either 50 or 140 diameters, and in most cases a scale is appended to them. The measurements have been expressed in the decimal parts of an inch except in some few instances among the wood-cuts where the metric system has been used, but this is always marked on the figures.

The subjoined Table is given for the ready conversion of one system into the other.

Inches.	Millimetres.	Inches.	Millimetres.
·10	2·539	·60	15·239
·15	3·809	·65	16·509
·20	5·079	·70	17·779
·25	6·349	·75	19·049
·30	7·619	·80	20·319
·35	8·889	·85	21·589
·40	10·159	·90	22·859
·45	11·429	·95	24·129
·50	12·699	1·00	25·399
·55	13·969		

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ABBREVIATIONS.

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DESCRIPTION OF GENERA AND SPECIES.

Sub-Order I. CHEILOSTOMATA.

Division I.—STOLONATA.

Family I. Æteidæ.

Ætea, Lamouroux.

Family II. Eucrateadæ.

1. *Eucratea*, Lamouroux.
2. *Hippothoa*, Lamouroux.
3. *Pasythea*, Lamouroux.
4. *Brettia*, Dyster.

Family III. Chlidoniadæ.

Chlidonia, Savigny.

Family I. Æteidæ.

Æteidæ, Smitt, Hincks.
Scrupariadæ (pars), Brit. Mus. Cat.
Stolonata (pars), Carus.

Character.—Zoœcia tubular, with a subterminal membranous area; partly erect and free, partly decumbent and adherent; uniserial.

Ætea, Lamouroux.

Sertularia (pars), Linn., Delle Chiaje.
Cellularia (pars), Pallas.
Cellaria (pars), Solander.
Ætea, Lamx. [1812], Brit. Mus. Cat., Smitt, Hincks, &c.
Falcaria, Oken.
Anguinaria, Lamk. [1816], Fleming, Schweigger, Cuvier, Blainv., Busk, 1849; Gosse, Lister.

Character.—Zoœcia calcareous but more or less flexible; tubular, partly erect, partly horizontal; the horizontal portions forming a segmented, adnate fistular horizontal stolon. A large membranous area on one side towards the end of the erect portion. Orifice semicircular, subterminal.

Ætea anguina, Linné (sp.).

"*Snake Coralline*," Ellis.
Sertularia anguina, Linn.
Cellularia anguina, Pallas, Ellis.
Cellaria anguina, Solander.
Ætea anguina, Lamx., Brit. Mus. Cat., Smitt, Hincks, &c.
Falcaria anguina, Oken.
Sertularia mollis, Delle Chiaje.
Anguinaria anguina, Fleming, Lister,
„ *spatulata*, Lamk., Johnst., Busk, 1849, Gosse, &c.

Character.—Zoœcia curved towards the end and spatulate; surface finely annulate, except the spatulate part, in which the surface is finely spotted.

Habitat.—Station 36, off Bermuda, 30 fathoms, coral. Station 161, off Port Philip, 33 fathoms, sand. Stations 135A, &c., off Inaccessible Island, and Nightingale Island, Tristan da Cunha, 75 and 110 fathoms. Station 304, lat. 46° 53′ S., long. 75° 12′ W., 45 fathoms, green sand. Station 162, off East Moncœur Island, 38 to 85 fathoms, sand and shells.

Family II. EUCRATEADÆ.

Eucratiidæ (pars), Hincks.
Scrupariadæ (pars), Brit. Mus. Cat.

Character.—Zoœcium erect and free or decumbent, more or less adnate. Zoœcia uni- or biserial or geminate, pyriform, with a subterminal oblique orifice; unarmed.

The following genera are contained in the Collection:—

1. *Eucratea.*

(1) *Eucratea chelata* (Linné).

2. *Hippothoa.*

(1) *Hippothoa divaricata*, Lamouroux.

(2) *Hippothoa flagellum*, Manzoni (Pl. XXXIII. fig. 7).

3. *Pasythea.*

(1) *Pasythea eburnea* (Smitt) (Pl. XXXIV. fig. 1).

4. *Brettia.*

(1) *Brettia australis*, n. sp. (Pl. XXXIV. fig. 3).

(2) *Brettia cornigera*, n. sp. (Pl. XXXIV. fig. 6).

1. *Eucratea*, Lamouroux.

Scruparia, Brit. Mus. Cat., vol. i. p. 28, Oken [1813], &c.
Eucratea, Lamx. [1812], Johnst., Fleming, d'Orb. (pars), Smitt, Hincks, Auctt.
Unicellaria (sp.), Blainv.
Catenaria (pars), d'Orb.
Cellularia (pars), Pallas.
Cellaria (pars), Solander.
Sertularia (sp.), Linn.

Character.—Zoœcium usually with a creeping adherent base, erect, branching. Zoœcia calcareous, rising one from another singly. Aperture oblique, terminal or subterminal. Orifice semicircular, with a straight lower border. Branches springing from the front of a zoœcium below the aperture.

Eucratea chelata, Linné (sp.).

Sertularia chelata, Linn.
Cellularia chelata, Pallas, Bruguière, Bosc, Lamk.
Cellaria chelata, Ell. and Soland.
Eucratea chelata, Lamx., Johnst., Hincks, Smitt, Gosse, Alder, &c.
Scruparia chelata, Oken, Brit. Mus. Cat., Gray, Gosse, Wyv. Thoms., Hincks, Smitt, 1865.
Eucratea loricata, Fleming.
Unicellaria chelata, Blainv.
Catenaria chelata, d'Orb.
Crisia chelata, Johnst., Hassall.
Eucratée cornée, Milne-Edw.

Character.—Zoœcia in the form of a horn, short. Aperture oval, oblique; peristome thin, raised, membranous part of front depressed. Orifice semicircular. Branches arising from the front of a zoœcium close below the aperture (often aborted). Oœcia mitriform, acuminate, subcarinate.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

[Cosmopolitan.]

2. *Hippothoa*, Lamouroux.

Catenicella (pars), Blainv.
Tubalipora, sp., Jameson.
Mollia (pars), Smitt.

Character.—Zoœcia calcareous, decumbent, adherent, usually distant and connected by tubular prolongations. Branches given off from the sides of a zoœcium. Orifice orbicular, sometimes produced and subtubular, with a sinus in the lower border.

(1) *Hippothoa divaricata*, Lamouroux.

Hippothoa divaricata, Lamx., Brit. Mus. Cat., Johnst., Auctt.
Mollia hyalina, forma *divaricata*, Smitt, Öfversigt k. Vetensk.-Akad. Förhandl., 1867.

Character.—Zoœcia ovate or pyriform. Surface usually striated transversely, and subcarinate in front. Orifice orbicular, with a median notch below.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud. Station 135, Islands of Tristan da Cunha, 60 to 1000 fathoms, hard ground, shells and gravel.

[Cosmopolitan.]

(2) *Hippothoa flagellum*, Manzoni (Pl. XXXIII. fig. 7).

Hippothoa flagellum, Manz. Brioz. fossil., Ital. 4th Contrib, p. 6, pl. i. fig. 4; Suppl. alla Fauna d. Brioz. Medit.; 1st Contrib, p. 3, pl. i. fig. 5. (?); Hincks, Ann. and Mag. Nat. Hist. ser. 4, vol. xx. p. 218, 1877; Brit. Mar. Polyz., vol. i. p. 293, pl. xliv. figs. 5, 7.

Character.—Zoœcia ovate, smooth, not carinated, slightly elevated towards the upper end, not much produced below; connected by very slender, tubular processes; much longer than the zoœcium. Orifice subclithridiate; peristome slightly thickened. (Oœcia small, globose, smooth, borne on a partially developed cell, generally attached to the side of a normal zoœcium by a very short fibre, Hincks.)

Habitat.—Station 151, off Heard Island, 75 fathoms, volcanic mud (parasitic on *Myriozoum marionense*).

[Cosmopolitan; Pliocene.]

3. *Pasythea* (pars), Lamouroux.

Cellaria (pars), Solander.
Sertularia (pars), Gmeli.
Liriozoa, Lamk.
Tuliparia, Blainv.
Epicaulidium, Hincks.
Gemellipora (pars), Smitt.

Character.—Zoœcium, in the erect portion, consisting of a central stem formed either of calcareous clavate segments or of successive pairs of zoœcia. From the sides of the

stem opposite branches arise, consisting either of a single triplet, or of a succession of geminate zoœcia. Zoœcia connate, urceolate, contracted towards the orifice, which is suborbicular, with a minute articular notch on each side below.

In Dr. Solander's posthumous work, a species of *Cellaria* is described under the name of *Cellaria tulipifera*,[1] and also a species of *Sertularia* (*quadridentata*),[2] and excellent figures of both are given.

Lamouroux, fancying some resemblance between the figures of these two species, conjoined them into a distinct genus, *Pasythea*, which was included by him in his Order Sertularieæ.

He notices, however, the probability of their belonging to different genera.

About the same time Lamarck, perceiving, as Dr. Solander had done, the true affinities of the two forms, bestowed upon *Cellaria tulipifera* the name of *Liriozoa*, relegating the second species to its proper place among the Sertularians.

In 1834 Blainville,[3] with much less excuse, fell into the same error as Lamouroux, and reunited the two species into a Sertularian genus *Tuliparia*, in glaring defiance of all rules of nomenclature and without any apparent reason.

The only subsequent notice of *Pasythea* with which I am acquainted is that recently published by Mr. Hincks, who appears to have inadvertently overlooked the previous accounts of the species, and bestowed upon it the name of *Epicaulidium pulchrum*,[4] which, however, he afterwards corrected.[5]

Under these circumstances it may perhaps admit of question as to whether priority should be given to Lamouroux' or to Lamarck's appellation. But as in date it seems probable, though by no means certain, that the former was slightly in advance, it seems as well to adopt his name. The trifling point is not worth discussion.

Pasythea tulipifera is a very interesting form, but as it does not occur in the Challenger collection I need not notice it more particularly here. Nor in fact is there much to add to the excellent and succinct description of Dr. Solander, and that recently given by Mr. Hincks.

Pasythea eburnea, Smitt (sp.) (Pl. XXXIV. fig. 1).

Gemellipora eburnea, Smitt, Florid. Bryoz., pt. 2, p. 35, pl. vii. figs. 152–156, and pl. ix. figs. 177*a*, 178.

Character.—Zoœcium in the erect portion pinnate. Stem at first a double calcareous tube, then a succession of geminate zoœcia, of which two pairs constitute an internode,

[1] *Loc. cit.*, p. 27, pl. v. figs. a, A.
[2] *Ibid.*, p. 57, pl. v. figs. g, G.
[3] Man. d. Actinol., p. 485, pl. lxxxiii. fig. 1.
[4] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vii. p. 156, pl. x. fig. 5, 1881.
[5] *Ibid.*, vol. viii. p. 135.

from the sides of which equidistant, opposite pinnæ, also composed of geminate zoœcia, are given off at right angles. Zoœcia geminate, closely connate, subcompressed, the oral portion subtubular and twisted round to opposite faces, front and back, in each pair. Surface smooth, entire, with a row of four to six puncta on each side, and a few on the front. Peristome slightly thickened.

Habitat.—Station 122, lat. 9° 5′–10′ S., long. 34° 49′–53′ W., 32 to 400 fathoms, red mud. Station 24, off Culebra Island, 390 fathoms, Pteropod ooze. Station 23, off Sombrero Island, 450 fathoms, Pteropod ooze. Off Barra Grande, Brazil, 400 fathoms.

[Gulf of Florida, 120 to 127 fathoms, Pourtalès.]

This very remarkable form affords a striking example of dimorphism. Though well described in most respects by Prof. Smitt, in both its forms, that excellent observer does not appear to have noticed the precise way in which the two are connected. "The species," he says, "in its erect state, from its ivory-white aspect and delicate stem, to the naked eye much resembles a *Crisia*. But closer examination shows the zoœcia to be arranged much as they are in *Gemellaria*, back to back in pairs, and apparently spirally arranged round an imaginary axis, owing to the circumstance that the zoœcia in the same longitudinal series have their mouths turned alternately to right and left." The stem and branches, as observed by Prof. Smitt, are articulated or divided into internodes, which in the stem consist of two or three pairs of zoœcia, from the lower pair of which alone the lateral branches arise, exactly opposite to each other; each branch springing from one of the two zoœcia.

Prof. Smitt does not appear to have met with specimens showing the mode in which the erect portion originates, and his description of the adnate zoœcia, and of the stoloniform tubes on which they are formed, does not convey exactly the true nature of the latter. In the specimen of *Pasythea eburnea* procured off Sombrero Island, the mode of origin and the nature of the connection between the adnate and erect portions are beautifully displayed.

On a small fragment of Coral or *Myriozoum*, four or five very young growths are seated, each of which arises from the centre of a circular, somewhat tumid disc, which is hollow, with thin, transparent, slightly calcified walls. The first internode of the erect stem consists of a double connate tube. The subsequent internodes are developed, each into two or three pairs of zoœcia, the lowermost one or two being more or less abnormally formed. From the outer border of this radical disc proceed four or five very slender and delicate, adnate stoloniform jointed tubes, upon which at rare intervals a decumbent Hippothoiform zoœcium, of the same size and form, as those in the erect part of the growth, is developed; whilst the tube itself connects one central disc with another. The occurrence of zoœcia in the course of the stoloniform tubes gives the growth very much the aspect, as Prof. Smitt remarks, of a dwarf *Hippothoa divaricata*.

When the calcareous matter is removed by weak acid, the chitinous basis of the zoœcia is seen to be very delicate and transparent; and in this condition the puncta visible in the wall of the zoœcium in its natural state appear as oval rings, occupied by a delicate membrane (fig. 1, *e*), in the centre of which is a nuclear mass, consisting of five or six highly refractive globular particles. The puncta, therefore, as in many other cases, are not truly pores, but appear to be of the same nature as the common interzoœcial discs or so-called "Rosettenplatten."

4. *Brettia*, Dyster.

Brettia, Dyster, Quart. Journ. Micr. Soc., vi., 1858, p. 260; Hincks, Brit. Mar. Polyz., p. 27.

Character.—Zoœcium erect, corneous or subcorneous. Zoœcia given off from the upper and back part of the subjacent one, above and behind the aperture; all facing the same way; uniserial, elongate, tubular or trumpet-shaped, with a large terminal or subterminal aperture, and a small semicircular orifice. (Margin of aperture with or without spines.)

(1) *Brettia australis*, n. sp. (Pl. XXXIV. fig. 3).

Character.—Zoœcium very small, regularly dichotomising, each zoœcium giving off a pair. Zoœcia trumpet-shaped, slightly curved. Aperture oblique or subterminal, rounded or oval. Margin unarmed.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground. (Parasitic on *Bicellaria bella.*)

Only a single minute specimen of this very elegant species has been noticed in the collection. It is excessively delicate and transparent, but at the same time presents a pearly aspect, showing that it is not wholly "corneous."

(2) *Brettia cornigera*, n. sp. (Pl. XXXIV. fig. 6).

Character.—Zoœcium lax, composed of dichotomous branches, springing from a common stem formed of radical tubes. Lower internodes very long and tubular, with a rudimentary aperture and uninhabited. Upper ones trumpet-shaped, much elongated and tubular downwards, with an oval aperture nearly half the length of the cell; four small pointed submarginal spines above, in front, and two behind. Oœcia, 0 (?) Avicularia, 0.

Habitat.—Station 23, off Sombrero Island, 450 fathoms, Pteropod ooze.

Family III. Chlidoniadæ.

Character.—Zoœcium composed of upright, free, segmented stems, springing from a stolonate network. From the segments, after the first bifurcation, arise lateral branches consisting of chains of zoœcia arising from the back near the summit. Zoœcia bicamerate; unarmed.

Chlidonia, Savigny.

Chlidonia, Savigny [1811], d'Orb., 1850.
Eucratea, Audouin.
? *Vorticella*, Linn., Esper.
Cothurnicella, Wyv. Thoms.

Character.—Free portion of the zoœcium composed of segmented tubular stems, with distant short branches, each springing from one of the internodes of the stem, and giving off numerous uniserial chains of zoœcia, one rising from the back of another near the top, and all looking one way. Zoœcia gibbous, pyriform, or attenuated downwards. Orifice prominent or subtubular, semicircular, lower lip entire, straight. The cavity of the zoœcium divided into two chambers, the hinder of which is much curved, and alone communicates with the orifice and lodges the polypide.

This very remarkable form, originally named *Chlidonia*[1] by M. Savigny, was afterwards renamed *Eucratea* by Audouin. It is, however, quite distinct from that genus, and M. d'Orbigny was fully justified in returning to the original appellation. As remarked by M. d'Orbigny (Palæont. Franç., p. 40), *Chlidonia* is clearly distinguished from *Catenicella* and *Catenaria* by its general habit; and its peculiarities appear to me to be such as fairly to entitle it to become the type even of a distinct family.

Each of the lateral branches supporting the tufts of zoœcial chains, springs from a distinct short forked internode of the non-celliferous main stem, whose internodes, as remarked by M. d'Orbigny, represent aborted zoœcia. The stem may, in fact, be regarded as a much developed radical tube, and in like manner each secondary branch and the chains of zoœcia are manifestly nothing more than successive internodes, which in the latter are dilated into habitations for the Polypides. Another remarkable peculiarity, though not one altogether confined to this genus, is seen in the partition of the interior of the zoœcium into two distinct chambers, apparently having no communication between them.

Chlidonia cordieri, Audouin (sp.) (Pl. XXVIII. fig. 11).

Eucratea cordieri, Audouin, Expl. i. p. 243, Savigny, Egypte, pl. xiii. fig. 3.
Chlidonia cordieri, d'Orb., Palæont. Franç., p. 40.
Cothurnicella dædala, Wyv. Thoms., Nat. Hist. Rev., vol. v. p. 146.

Character.—Zoœcia small, much attenuated or tubular downwards.

Habitat.—Station 186, Cape York, 8 to 11 fathoms, coral mud.

[1] Only at the bottom of the Plate.

At first sight I had regarded this form as specifically distinct from the well-known Atlantic and Mediterranean species; but upon further examination it is obviously to be regarded merely as a variety. The typical form has been described by Sir Wyville Thomson (Nat. Hist. Review, vol. v., 1858), from Port Philip, under the name of *Cothurnicella dædala*. The comparison of a specimen with which I was favoured by Sir Wyville Thomson, with one from "Egypt," shows that the two are identically the same. The species, therefore, would seem to be very generally distributed, occurring, according to d'Orbigny, in the Mediterranean and at the Canaries, and I have specimens from the coast of Calvados, from Nice, Egypt (Sir Jos. Banks), and Tyre (Mrs. Gatty).

Division II.—RADICELLATA.

Group A. CELLULARINA.

Family IV. Catenariadæ.

Catenaridæ (pars), d'Orb., 1850–52.
Catenicellidæ, Scrupariadæ (pars), Busk, 1852.
Cellularieæ (pars), Smitt.

Character.—Zoœcium radicate, segmented, internodes, except at a bifurcation, formed of a single zoœcium.[1]

The Challenger Collection contains the following genera:—

1. *Catenicella*, Blainville.

§ α. *fenestratæ.*

(1) *Catenicella ventricosa*, Busk.
(2) *Catenicella hastata*, Busk.
(3) *Catenicella plagiostoma*, Busk.
(4) *Catenicella cribraria*, Busk (Pl. I. fig. 6).

§ β. *vittatæ.*

(5) *Catenicella sacculata*, n. sp. (Pl. I. fig. 7).
(6) *Catenicella elegans*, Busk (Pl. I. figs. 2, 3, 5).
(7) *Catenicella umbonata*, Busk (Pl. I. fig. 1).
(8) *Catenicella pulchella*, Maplestone (Pl. I. fig. 4).

[1] In *Calpidium*, the internode may be said to be bi- or tri-locular, as it presents in front two or three oval orifices, although behind it exhibits no trace of division.

2. *Catenaria*, Savigny.

(1) *Catenaria attenuata*, n. sp. (Pl. II. fig. 1).
(2) *Catenaria bicornis*, n. sp. (Pl. II, fig. 2).
(3) *Catenaria diaphana*, Busk (Pl. II. fig. 3).

1. *Catenicella*, Blainville.

Catenicella (pars), Blainv., d'Orb., Brit. Mus. Cat., &c.
Catenaria (pars), Savigny.
Eucratea (sp.), Audouin.
Cellaria (pars), Lamk.

Character.—Internodes usually unicellular; the zoœcia arising one from the upper and back part of another, by a corneous tube, all facing the same way and forming dichotomously divided branches of an erect phytoid zoœcium. The zoœcium at each bifurcation geminate; each zoœcium with two lateral, usually trilocular, processes (*alæ*). Oœcia either subglobose and terminal or immersed, and placed below the orifice of a zoœcium in front.

§ *a. fenestratæ.*

Front fenestrate. Oœcia terminal.

(1) *Catenicella ventricosa*, Busk, var. *maculata.*

Catenicella ventricosa, var. *maculata*, Bk., Brit. Mus. Cat., vol. i. p. 7, pl. iii. figs. 4, 5.
Cellaria catenulata, Lamk.

Character.—Zoœcia ovate, compressed. Alæ wide, having sometimes a cup-like cavity above, which is occasionally closed, and formed into a broad conical spine. Fenestræ seven, with fissures radiating towards a rounded central pore. Surface of front studded with minute acuminate papillæ; back smooth, sometimes with dark spots.

Habitat.—Station 163A, off Twofold Bay, lat. 36° 57′ S., long. 150° 34′ E., 150 fathoms, green mud.

[Bass Strait, 45 fathoms, Voy. of Rattles.; Victoria, Macgillivray.]

(2) *Catenicella hastata*, Busk.

Catenicella hastata, Bk., Brit. Mus. Cat., vol. i. p. 7, pl. ii. figs. 3, 4; Voy. of Rattles., vol. i. p. 355; Macgilliv., Nat. Hist. Vict. Dec. iii., p. 19, pl. xxiv. fig. 4.
Catenicella bicuspis, Gray, Dieffenb., N. Z., vol. ii. p. 293.

Character.—Zoœcia ovate. Fenestræ numerous, disposed round a scutiform area, with fissures radiating towards the middle line. Lateral processes very wide, upper

loculus large, pyramidal, compressed, with five or six perforations before and behind. Dorsal surface finely sulcate.

Habitat.—Station 162, off East Moncœur Island, 38 fathoms, sand and shells. Station 161, off Port Philip, 33 fathoms, sand. Station 163A, off Twofold Bay, 150 fathoms, green mud.

[Bass Strait, 45 fathoms, Voy. of Rattles.; New Zealand, Dieffenb.; Queenscliff, &c., Victoria, Macgillivray.]

(3) *Catenicella plagiostoma*, Busk.

Catenicella plagiostoma, Brit. Mus. Cat., vol. i. p. 8, pl. v. figs. 1, 2; Voy. of Rattles., vol. i. p. 358, Macgilliv., *loc. cit.*, p. 17, pl. xxiv. fig. 2.
Cellaria catenulata (pars), Lamk.

Character.—Zoœcia large, wide, ovoid. Front divided into five large subtriangular fenestræ by four broad bands. Orifice arcuate, with a straight entire lower lip, and placed obliquely. Lateral processes very large (sometimes only on one side), rising into an acute spinous point and deeply cupped above. Avicularian loculus variable in size, sometimes more than half the length of the cell. Dorsum with a broad central band and two narrower bands branching from it on each side. Surface between the bands beset with setose spines.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud. Station 163B, Port Jackson, 35 fathoms, hard ground.

[Bass Strait, 45 fathoms; Swan Island, Banks Strait, Voy. of Rattles.; Victoria, "very common" Macgillivray.]

(4) *Catenicella cribraria*, Busk (Pl. I. fig. 6).

Catenicella cribraria, Brit. Mus. Cat., vol. i. p. 9, pl. v. figs. 3, 4; Voy. of Rattles., vol. i. p. 359, Macgilliv., *loc. cit.*, p. 20, pl. xxiv. fig. 6.

Character.—Zoœcia subglobose, compressed. Fenestræ numerous, punctiform, equidistant, the circumferential larger than the rest. A minute central crescentic pore. Orifice semicircular, lower lip straight, entire (when perfect); lateral processes with the upper loculus suppressed, and the lowest prolonged downwards, forming an elevated wing on each side. Dorsal surface smooth.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand.

[Bass Strait, Hooker; Cook's Strait, New Zealand, Lyall; Queenscliff, &c., Victoria Macgillivray.]

I have added a figure of this form, as that in the Brit. Mus. Cat. scarcely gives a fair representation of it.

§ β. *vittatæ.*

(5) *Catenicella sacculata*, n. sp. (Pl. I. fig. 7).

Character.—Zoœcia elongated and attenuated downwards. Surface highly polished. A small delicate-walled pouch in front of the lower lip with four or five minute punctures. Orifice arcuate, with an entire lower lip. Lateral processes very small, reduced almost entirely to a small avicularium. Vittæ wide and long-pointed at each end, and with a single row of dots down the middle.

Habitat.—Station 122, lat. 9° 5′ S., long. 34° 49′–53′ W., 32 to 400 fathoms, red mud.

At first sight this might be taken for a very robust form of *Catenicella elegans*, but they differ very materially. The chief differences are:—1, The presence of a small perforated pouch immediately in front of the orifice, and formed as it would seem by the protrusion of the lower lip; 2, the great width and peculiar form of the vittæ; 3, the perfectly smooth surface; and 4, the comparatively stunted condition of the lateral processes, in which the superior and inferior loculi are aborted, and the correspondingly minute size of the avicularia.

(6) *Catenicella elegans*, Busk (Pl. I. figs. 2, 3, 5).

? *Eucratea contei*, Aud., Exp. i. 242; Savigny, Egypte, pl. xiii. fig. 1.
Catenicella savignyi, Blainv., Man. d. Actinol., p. 462, pl. lxxviii. fig. 5.
„ *elegans*, Bk., Voy. of Rattles., vol. i. p. 361, pl. i. fig. 2; Brit. Mus. Cat., vol. i. p. 10, pl. ix.; Macgilliv., Nat. Hist. Vict. Dec., iii. p. 23, pl. xxiv. fig. 10.

Character.—Zoœcia slender, ovoid, surface finely papillose. Oœcial cell geminate. Lateral processes reduced to the avicularian loculus, which is usually large and projecting, with a perforation at the base. Vittæ long, narrow, with a single series of dots.

Habitat.—Station 122, lat. 9° 5′ S., long. 34° 49′ W., 32 to 400 fathoms, red mud. Station 188, lat. 9° 59′ S., long. 139° 42′ E., 28 fathoms, green mud. Station 135, Tristan da Cunha, 60 to 1100 fathoms, hard ground, shells, gravel. Station 163A, off Twofold Bay, 150 fathoms, green mud.

[Bass Strait, 47 fathoms; Port Cooper, Banks' Peninsula; Algoa Bay; Port Dalrymple; Madeira, J. G. J.; Mediterranean or Red Sea, Savigny; Victoria, Macgillivray.]

Mr. Macgillivray remarks that in most of the specimens with ovicells the lateral processes are very small. In any case, however, they vary a good deal in size. In some cases (fig. 5) the surface seems to be quite smooth, presenting none of the minute papillæ.

(7) *Catenicella umbonata*, Busk, var. (Pl. I. fig. 1).

Catenicella umbonata, Bk., Brit. Mus. Cat., vol. i. p. 11, pl. x. figs. 4, 5; Voy. of Rattles., vol. i. p. 362.

Character.—Zoœcia pyriform, contracted below, bulging or ventricose above. Lateral processes reduced to the avicularian loculus, which is large and strong, usually with a perforated border above (probably representing the superior loculus). Vittæ long and narrow, extending from the level of the mouth to the bottom of the zoœcium, usually furnished with acuminate papillæ. A broad compressed projecting process on the middle of the back.

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

[Bass Strait, 45 fathoms, Voy. of Rattles.; Tasmania, Mrs. Smith.]

The variety in the Challenger collection differs from the typical form in its great delicacy of structure, and the only occasional presence of the dorsal prominence. Nor does it show any papillary processes or vittæ, on the front.

(8) *Catenicella pulchella*, Maplestone (Pl. I. fig. 4).

Catenicella pulchella, Maplest., Journ. Micr. Soc. Victoria, vol. i. (1880), p. 64, pl. v. fig. 4.

Character.—Zoœcia flattened in front, convex behind, ovate in outline, surface quite smooth. Orifice semicircular, lower lip emarginate. A row of large circular raised spots on each side. Lateral processes short and thick, subconical, with a perforation at the base (seen on the side).

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

[Australia, Maplestone.]

"An interesting form" as Mr. Maplestone remarks, and at first sight scarcely referrible to either the fenestrate or vittate section. But it appears properly to belong to the latter. The lateral series of elevated discoid spots may be regarded as homologous with the vittæ, and as in the other *Vittatæ*, the oœcia are not terminal, but as Mr. Maplestone says "geminate and not terminal."

The lateral spots are completely covered with a sort of convex lid, and have the aspect of pustulose elevations.

Catenicella pulchella differs from *Catenicella rufa* in its white colour and the absence of puncta all over the front, as well as in the absence of the peculiar dorsal stigmata which exist in the latter species.

2. *Catenaria*, Savigny.

Catenaria (pars), Savigny, 1811 (on Plates); (pars), d'Orb., Palæont. Franç., p. 42, 1850–1852.
Eucratea (pars), Audouin (*nec* Lamx., Blainv.).
Alysidium (pars), Bk., Brit. Mus. Cat., 1852.

Character.—Zoarium erect or free, dichotomously branched; the zoœcium at each bifurcation single. Zoœcia elongate, subtubular or trumpet-shaped, without a frontal aperture. Mouth orbicular or semi-orbicular. Avicularia present or absent.

The typical species I have assumed for this genus is the *Eucratea lafontii* of Audouin (Savigny, Egypte, pl. xiii. fig. 2).

(1) *Catenaria attenuata*, n. sp. (Pl. II. fig. 1).

Character.—Zoarium extremely delicate, laxly spreading. Zoœcia very long, slender, tubular below, trumpet-shaped above. Orifice large arcuate; lower lip entire, straight. Avicularia, 0. Oœcia (?).

Habitat.—Station 151, off Heard Island, 75 fathoms, volcanic mud.

(2) *Catenaria bicornis*, n. sp. (Pl. II. fig. 2).

Character.—Zoarium plumose, very delicate. Zoœcia tubular below, ventricose and ovate or subglobular above. Surface highly polished. Front occupied almost entirely by an oval bordered area (not membranous), in which is a median pore immediately below the mouth, and several others arranged in a crescentic series on each side; all the pores surrounded by a thickened border. Orifice semicircular; lower lip straight, entire. A retrocedent sessile avicularium behind each upper angle. Oœcium galeriform, ofty, terminal.

Habitat.—Station 280, lat. 18° 40′ S., long. 149° 52′ W., 1940 fathoms, Globigerina ooze.

(3) *Catenaria diaphana*, Busk (Pl. II. fig. 3).

Scruparia diaphana, Bk., Quart. Journ. Micr. Sci., vol. viii. p. 281, pl. xxxi. figs. 1, 1*a*.

Character.—Zoarium irregularly ramose. Zoœcia pyriform, elongated; anterior wall sparsely punctured, with a slender continuous vitta (?) on each side. Orifice orbicular, slightly sinuated below. Peristome thin, subtubular, entire.

Habitat.—St. Paul's Rocks, North Atlantic, shallow water.

[Madeira, J. Y. J.]

In the description of *Scruparia diaphana* (*loc. cit.*), the peristome is stated to be notched above, but this defective condition appears to be only occasional.

The separation of this peculiar form from *Catenicella* is entirely artificial, and it has been placed under *Catenaria* simply for its mode of branching, and the absence of any lateral appendages.

Family V. CELLULARIADÆ, Busk.

Cellulariidæ, Bk., Crag Polyzoa, p. 19; Hincks.
Cellulariadæ, Brit. Mus. Cat.
Cellularidæ (pars), Johnst.
Cellularieæ (pars), Smitt.

Character.—Zoarium articulated, phytoid, erect, dichotomous, bi,- tri,- or multiserial. Zoœcia rising by a broad base, alternate, all facing the same way; a large oval membranous aperture. Avicularia, when present, sessile, and either lateral or anterior.

The Family contains the following genera:—

1. *Cellularia*, Pallas (pars).

§ α. *apertæ.*

(1) *Cellularia crateriformis*, n. sp. (Pl. III. fig. 1).
(2) *Cellularia cuspidata*, Busk.
(3) *Cellularia cirrata*, n. sp. (Pl. II. fig. 4).
(4) *Cellularia quadrata*, n. sp. (Pl. V. fig. 5).

§ β. *fornicatæ.*[1]

(5) *Cellularia biloba*, n. sp. (Pl. III. fig. 2).
(6) *Cellularia elongata*, n. sp. (Pl. III. fig. 3).

2. *Menipea*, Lamouroux.

§ α. *fornicatæ.*

(1) *Menipea benemunita*, n. sp. (Pl. IV. fig. 4).
(2) *Menipea aculeata* (d'Orbigny) (Pl. IV. fig. 2).
(3) *Menipea clausa*, n. sp. (Pl. IV. fig. 5).

§ β. *apertæ.*

(4) *Menipea flabellum*, Lamouroux.
(5) *Menipea flagellifera*, n. sp (Pl. IV. fig. 1).
(6) *Menipea marionensis*, n. sp. (Pl. IV. fig. 3, and Pl. XIV. fig. 9).
(7) *Menipea triseriata*, Busk.
(8) *Menipea cirrata*, Lamouroux.
(9) *Menipea pateriformis*, n. sp. (Pl. V. fig. 4).

[1] A better term perhaps would have been "scutatæ," but as Prof. Smitt has introduced the term "fornix" for what I had originally named "operculum," now generally employed for the oral valve, I have adopted his name.

3. *Emma*, Gray.

Emma crystallina, Gray.

4. *Scrupocellaria*, van Beneden.

(1) *Scrupocellaria macandrei*, Busk (Pl. XI. fig. 4).
(2) *Scrupocellaria ciliata* (Audouin) (Pl. XI. fig. 5).
(3) *Scrupocellaria ornithorhynchus* (Wyv. Thoms.) (Pl. XI. fig. 6).
(4) *Scrupocellaria pilosa* (Audouin) (Pl. XI. fig. 7).
(5) *Scrupocellaria securifera*, n. sp. (Pl. XI. fig. 2).

5. *Canda*, Lamouroux.

(1) *Canda arachnoides*, Lamouroux.
(2) *Canda simplex*, n. sp. ? (Pl. XIV. fig. 8).

6, *Nellia*, Busk.

(1) *Nellia oculata*, Busk.
(2) *Nellia simplex*, Busk (Pl. V. fig. 6).

7. *Caberea*, Lamouroux.

§ *α. fornicatæ.*

(1) *Caberea rostrata*, n. sp. (Pl. XXXII. fig. 4).
(2) *Caberea crassimarginata*, n. sp. (Pl. XI. fig. 1).
(3) *Caberea darwinii*, Busk (Pl. XXXII. fig. 6).
(4) *Caberea rudis*, Busk.
(5) *Caberea minima*, n. sp. (Pl. XXXII. fig. 5).

§ *β. apertæ.*

(6) *Caberea lata*, Busk (Pl. XI. fig. 3).

1. *Cellularia*, Pallas (pars).

Bugula (pars), Gray.

Character.—Zoarium bi- or tri-serial, with more than four cells in each internode; with or without a sessile avicularium behind the upper and outer angle; with or without a pedunculate fornix.

§ *α. apertæ.*

(1) *Cellularia crateriformis*, n. sp. (Pl. III. fig. 1).

Character.—Zoarium 2 to 3 inches high, lax, flaccid, straggling, branches long, very irregular. Zoœcia elongated, narrow (0″·04 × ·005). Aperture oval, border wide,

and raised into an expanded cup. Two (sometimes only one) very strong and long, jointed spines on the outer side, and a slender unjointed one on the inner side, above. Avicularium (sometimes absent) rather large, mandible triangular, pointed, not curved. Oœcium lofty, surface smooth, lower border simple entire.

Habitat.—Station 325, lat. 36° 44′ S., long. 46° 16′ W., 2650 fathoms, blue mud. Station 323, lat. 35° 39′ S., long. 50° 47′ W., 1900 fathoms, blue mud.

Peculiar in the very lax growth and straggling branches, all composed principally of interlaced radical tubes, supporting single or sets of zoœcia at irregular distances apart. The cup-like expansion also around the aperture is very characteristic, and the two occasionally very large jointed spines on the outer side much resemble the antennæ of an insect. One of these apparently arises, not from the margin of the aperture, but behind it. Occasionally a radical tube may be seen supporting, instead of an ordinary zoœcium, a small curiously formed avicularium.

(2) *Cellularia cuspidata*, Busk.

Cellularia cuspidata, Bk., Brit. Mus. Cat., vol. i. p. 19, pl. xxvii. figs. 1, 2.
,, *monotrypa*, Bk., Voy. of Rattles., vol. i. p. 368.

Habitat.—Station 161, off entrance to Port Philip, 33 fathoms, sand.
[Australia; New Zealand, Darwin, Hooker, Lyall, &c.]

Mr. Hincks (Brit. Mar. Polyz., p. 36) remarks that the presence of the cuspidate point on the median cell at each bifurcation is not a distinctive mark of the Australian *Cellularia cuspidata*, but belongs to *Cellularia peachii* as well. If this be the case, it might perhaps be proper to recur to my original name of *Cellularia monotrypa* to distinguish the former. But the presence of a cusp cannot by any means be constant, at any rate in the British form, as it is totally wanting in the only specimen I have seen, and from which my original description of *Cellularia peachii* (Ann. and Mag. Nat. Hist., ser. 2, vol. vii. p. 82, pl. viii. figs. 1, 2, 3, 4) was drawn up.

(3) *Cellularia cirrata*, n. sp. (Pl. II. fig. 4).

Character.—Zoarium about 3 inches high. Branches much curled and interlaced, forming a dense tuft. Zoœcia entirely open and sessile, with a broad base. Orifice broad-oval, contracted at the summit, margin rather thick, smooth. A blunt, curved, acuminate point at the summit of each zoœcium, and a large avicularium behind the upper and outer angle. Oœcium formed of an entire metamorphosed zoœcium, with a wide opening closed by a broad valve having a semilunar chitinous border.

Habitat.—Station 195, lat. 4° 21′ S., long. 129° 7′ E., 1425 fathoms, blue mud.

The general structure of this species is very peculiar, and together with other characters might perhaps justify its erection into a distinct genus. The cells, different from those of nearly all the other Cellulariadæ, are entirely open in front, and of equal width throughout below the immediate summit, which is contracted to the width of the crescentic mouth. They are seen to arise, when viewed from behind, by a very broad base, from the side as it were, of the subjacent cell. The consequence of this is that they are all placed obliquely with respect to the axis of the branch, standing out on either side with extreme regularity. The only specimen in the collection is about three inches high, and the curling branches form a thick entangled tuft, very difficult to unravel. The main stem is of considerable thickness, and composed of a closely packed bundle of radical tubes, which at the lower extremity break up into innumerable and very fine jointed filaments, each of which becomes attached to a *Globigerina*-shell, or other small solid particle, the whole forming a thick floccose tuft, composed of the fibres and attached particles.

(4) *Cellularia quadrata*, n. sp. (Pl. V. fig. 5).

Character.—Ten to fourteen zoœcia in each internode, biserial, the two series facing different ways at a slight angle. Zoœcia quadrate, entirely open in front, the aperture slightly contracted by a very narrow lamina. Surface of border and lamina very delicately frosted. Dorsal surface smooth entire. A small lateral avicularium slightly in front of the superior angle.

Habitat.—Station 149D, Royal Sound, Kerguelen, 28 fathoms, volcanic mud. Station 151, Heard Island, 75 fathoms, volcanic mud.

Closely allied, apparently, to *Menipea ornata*, but differs from it in the much less developed lamina, and the absence of any anterior avicularia, and the more elongated form of the cells, which in the former species are nearly square.

§ *β. fornicatæ.*

(5) *Cellularia biloba*, n. sp. (Pl. III. fig. 2).

Character.—Zoarium lax, straggling, branches very slender. Zoœcia trumpet-shaped. Orifice oval, with a much raised crateriform border. Four or five slender, oral spines, and a bilobed pedunculate fornix. A small avicularium situated quite behind the angle of every zoœcium, with an acute mandible pointing downwards.

Habitat.—Station 76, lat. 38° 11′ N., long. 27° 9′ W., 900 fathoms, Pteropod ooze.

The avicularium is entirely posterior, and is not visible in a front view; and it is quite immersed.

(6) *Cellularia elongata* n. sp. ? (Pl. III. fig. 3).

Character.—Zoarium loosely branched, branches straight. Zoœcia much elongated, tubular, orifice oval, with a smooth thin border; three to five long slender acicular oral spines; an oval, entire, pedunculate fornix, nearly as large as the aperture. A small avicularium visible in front on most of the zoœcia.

Habitat.—Station 149D, Royal Sound, Kerguelen, 28 fathoms, volcanic mud.

A very delicate and beautiful species.

2. *Menipea*, Lamouroux.

Cellaria (pars), Linn. and Auctt.
Menipea, Lamx., d'Orb., Brit. Mus. Cat., Hincks, Wyv. Thoms., &c.
Crisia (pars), Lamx.
Tricellaria (sp.), Fleming, Blainv., Gray.
Cellularia (pars), Johnst., Smitt.
Cellarina (pars), v. Bened.

Character.—Zoœcia oblong, usually attenuated below, rising from a broad base; from three to fifteen in each internode. A sessile lateral avicularium (frequently aborted), and usually one or more sessile avicularia on the front below the aperture, or on a special tract between the series of zoœcia. Vibracularia, 0. With or without a pedunculate fornix.

§ *a. fornicatæ.*

(1) *Menipea benemunita*, n. sp. (Pl. IV. fig. 4).

Character.—Zoarium composed of short forked divaricate rather thick branches. Zoœcia tri- or quadri-serial. Orifice entirely covered by a large spatulate or spout-like fornix. Usually three spines on the outer side, of which the lowest is much smaller than the others, and one on the inner side; two sessile avicularia on the front of the median zoœcia, and one on the outer one placed below the orifice. Dorsal surface longitudinally wrinkled.

Habitat.—Station 313, lat. 52° 20′ S., long. 67° 39′ W., 55 fathoms, sand. Station 303, lat. 45° 31′ S., long. 78° 9′ W., 1325 fathoms, blue mud. Station 149H, I, K, Christmas Harbour, Kerguelen, 45 to 127 fathoms. Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel.

In this species the branches are all bordered by very closely adnate calcified radical tubes.

(2) *Menipea aculeata*, d'Orbigny (sp.) (Pl. IV. fig. 2).

Tricellaria and *Ternicellaria aculeata*, d'Orb., Voy. en Amér. Mérid., p. 8, pl. ii. figs. 1–4.
(?) *Menipea fuegensis* Bk., Kerg. Polyz., Phil. Trans., p. 194; Brit. Mus. Cat., vol. i. p. 21, pl. xix.

Character.—Zoœcia, three in each internode, much elongated and attenuated inferiorly. Aperture about one-third the length of the cell; bordered, slightly thickened. Three spines above; a small, bi- tri-furcate fornix. A small avicularium in front, below the aperture.

Habitat.—Station 303, lat. 45° 31′ S., long. 78° 9′ W., 1325 fathoms, blue mud. Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel.

[Kerguelen Island, Eaton; Patagonia, d'Orbigny.]

Menipea fuegensis, Brit. Mus. Cat., vol. i. p. 21, pl. xix., is of much stronger growth, and has four spines and a simple ligulate fornix; and the cells are less attenuated.

(3) *Menipea clausa*, n. sp. (Pl. IV. fig. 5).

Character.—Zoarium opaque ivory white, about 1 inch high, composed of few straggling, dichotomous branches, rising from a slender stem, composed of a close bundle of partially calcified radical tubes, the fibrous extremities of which are attached to dead Globigerina shells. Zoœcia much elongated, sub-cylindrical inferiorly, the upper third forming an oval dilatation; aperture wide, completely covered by a convex fornix, which is connate with the border of the aperture, and fissured all round except at the part where the pedicle of the fornix arises on the inner side. The mouth of the cell (the lower border of which is formed by the upper edge of the fornix) is semicircular. Two oral spines on the outer and one on the inner side of the mouth. A small avicularium in front below the aperture, and a very minute one behind the cell near the summit. Oœcia lofty, narrow; surface polished.

Habitat.—Station 70, lat. 38° 25′ N., long. 35° 50′ W., 1675 fathoms, Globigerina ooze.

This extremely beautiful form is remarkable for the peculiar development of the pedunculate fornix, which forms a complete calcareous cover to the aperture; but that this cover is in reality nothing more than a magnified fornix, is obvious from the circumstance that, like that appendage in many other cases, it is formed of concentric rings starting from the site of the peduncle.

The back of the branches is covered by numerous calcified radical tubes, each individual zoœcium apparently being supplied with one.

§ *β. apertæ.*

(4) *Menipea flabellum*, Lamouroux.

Cellularia ornata, Bk., Brit. Mus. Cat., p. 20, pl. xxvi. figs 3, 4.
? *Menipea flabellum*, Lamx.
Cellaria flabellum, Ell. and Soland.

Habitat.—Simon's Bay, Cape of Good Hope.
[Algoa Bay, Natal.]

(5) *Menipea flagellifera*, n. sp. (Pl. IV. fig. 1).

Character.—Zoœcia six to nine in each internode, obovate (viewed behind). Aperture about half the length, regularly oval. Peristome thin, quite smooth. A single oral spine above on the outer side. A small angular avicularium to every cell, and a pouch-like vibracularium on the front below the aperture.

Habitat.—Station 149D, Royal Sound, Kerguelen, 20 to 60 fathoms. Station 149H, I, K, off Christmas Harbour, 45 to 127 fathoms. Station 313, lat. 52° 20′ S., long. 67° 39′ W., 55 fathoms, sand. Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand. Off Marion Island, 50 to 75 fathoms.

(6) *Menipea marionensis*, n. sp. (Pl. IV. fig. 3, and Pl. XIV. fig. 9).

Character.—Nine to fifteen zoœcia in each internode, each series facing outwards so as to form an obtuse angle down the front of the branch; very little contracted below. Aperture oval, occupying rather more than half the length of the zoœcium. Margin thin, smooth, two slender spines on each side above. A lateral avicularium to each cell and a small one in front, below the aperture, and close to the median line of the branch. Oœcia shallow, cucullate, wall entire.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand. Off Marion Island, 50 to 75 fathoms.

I place this form under *Menipea*, solely on account of the anterior avicularium; in other respects it might as well be referred to the armed group of *Cellularia*.

(7) *Menipea triseriata*, Busk.

Menipea triseriata, Bk., Brit. Mus. Cat., p. 22, pl. xxiii. figs. 2, 3, 4.

Character.—Zoœcia oblong rectangular (behind), bi- or tri-serial, numerous (twelve to fourteen in the internode). Aperture oval, pointed at bottom, and there partially filled

in by a granulated lamina; one or two marginal spines on each side, above. Oœcia rounded, cucullate, smooth; lip of orifice entire.

Habitat.—Simon's Bay, Cape of Good Hope.

(8) *Menipea cirrata*, Lamouroux.

Menipea cirrata, Lamx., Hist. des Polypes, p. 145; Exp. Méth., p. 7, pl. iv. fig. D; Bk., Brit. Mus. Cat., vol. i. p. 21, pl. xx. figs. 1, 2; Krauss.
Cellaria cirrata, Ell. and Soland.
„ *crispa*, Pallas, Elench.
Sertularia crispa, Gmelin.
„ *cirrata*, Gmelin.
Tubularia cirrata, Esper, Seba.

Character.—Zoœcia pyriform, constricted below, six in each internode, one of the lower usually more or less aborted; usually one large lateral avicularium to each internode; three long, strong, marginal spines. Anterior avicularium single, its upper border toothed

Habitat.—Simon's Bay, Cape of Good Hope.

(9) *Menipea pateriformis*, n. sp. (Pl. V. fig. 4).

Character.—Zoarium branched, branches thick, almost cylindrical, arising from a loose tuft of radical fibres. Zoœcia tri- or quadri-serial, the lateral series facing outwards at a slight angle, oblong, with a regularly oval aperture occupying the upper three-fourths; the margin very thin, smooth and high. A large, prominent, sessile avicularium below the aperture in almost every zoœcium. Oœcia lofty, narrow, surface smooth, entire. Dorsal surface covered with radical tubes.

Habitat.—Station 299, lat. 33° 31′ S., long. 74° 43′ W., 2160 fathoms, blue mud.

3. *Emma*, Gray.

Emma, Gray, Dieffenb. New Zealand, vol. ii. p. 293; Bk., Voy. of Rattles., vol. i. p. 373; Brit. Mus. Cat., p. 27; T. W. Hutton.
Menipea (sp.), Wyv. Thoms.; Hincks.

Character.—Zoœcia in conjoined pairs or triplets in each internode (not opposite); much expanded above and contracted below. Upper part of front occupied by a wide subtriangular bordered area, partially filled in by a granular lamina; and with a suborbicular membranous aperture. A lateral sessile avicularium placed below the level of the aperture.

Emma crystallina, Gray.

Emma crystallina, Bk., Brit. Mus. Cat., vol. i. p. 28, pl. xl.

Character.—Zoœcia in pairs; one to three strong spines on the outer border of the area, of which the middle one is usually the longest and thickest.

Habitat.—Station 161, Port Philip, 33 fathoms, sand.

[Bass Strait, 45 fathoms, Voy. of Rattles.; New Zealand, Dieffenb.; Hooker, Hutton, Lyall; Strait of Magellan, Miss Gatty; Campbell's Island, Hooker.]

4. *Scrupocellaria*, van Beneden.

Scrupocellaria, v. Bened., Recherches, 1844; Hincks.
Bicellaria, sp., Blainv.
Cellularia, sp., Pallas, Johnst., Smitt, &c.
Cellaria, sp., Ell. and Soland., Lamk.
Scruparia, sp., Oken.
Canda, sp., Bk.

Character.—Zoœcia biserial, numerous in each internode, rhomboidal, with a sinus behind; a sessile avicularium on the upper and outer angle, and a vibraculum seated in the dorsal sinus of each zoœcium. Aperture oval or sub-rotund, with marginal spines above; with or without a fornix.

(1) *Scrupocellaria macandrei*, Busk (Pl. XI. fig. 4).

Scrupocellaria macandrei, Bk., Brit. Mus. Cat., vol. i. p. 24, pl. xxiv. figs. 1, 2, 3.

Character.—Zoarium 1 to 2 inches high, branches close, short, strongly serrated. Aperture sub-orbicular; fornix sub-orbicular, with a thick short stem, covering the entire aperture below the semicircular orifice, of which the lower lip appears to be formed by the upper border of the fornix. Border of aperture wide and thick below with a granular surface. Vibracula upright. Oœcia depressed, surface entire.

Habitat.—St. Vincent, Cape Verde Islands, 1070 to 1150 fathoms, mud. St. Paul's Rocks, North Atlantic.

[Coast of Spain, M'Andrew.]

(2) *Scrupocellaria ciliata*, Audouin (Pl. XI. fig. 5).

Crisia ciliata, Audouin, Egypte, Zool., pl. xii. fig. 2.
Scrupocellaria diadema, Bk., Brit. Mus. Cat., vol. i. p. 24, pl. xxviii. figs. 1, 2, 3.

Character.—Zoarium, mostly in one plane, branches rather long feathered. Aperture large, oval, with a thin smooth border; several marginal spines above (often wanting). Fornix with a slender upright pedicle and very irregularly shaped blade. Vibracularia

small, flagella capillary. Oœcia small, cucullate, perforated with one or two transverse rows of punctures. A row of small sessile avicularia in front.

Habitat.—Station 188, lat. 9° 59′ S., long. 139° 42′ E., 28 fathoms, green mud.

[Mediterranean ? Savigny; Moreton Bay, Voy. of Rattles.; Cape Verde Islands, Miss Gatty.]

(3) *Scrupocellaria ornithorhynchus*, Wyv. Thoms. (sp.) (Pl. XI. fig. 6).

Crisia ornithorhynchus, Wyv. Thoms.
(?) *Scrupocellaria clypeata*, Haswell, Proc. Linn. Soc. New South Wales, 1880, p. 37, pl. i. fig. 6.

Character.—Zoarium small, branches very slender, divaricate. Zoœcia rather distant. Aperture oval, border thin and smooth; two or three slender, pointed marginal spines on the outer side and one on the inner. Fornix with a wide peduncle, the lamina lobate, rounded below and produced into a more or less pointed lobe above. Vibracularia small, flagella minute.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

(4) *Scrupocellaria pilosa*, Audouin (sp.) (Pl. XI. fig. 7).

Crisia pilosa, Savigny, Egypte, pl. xii. fig. 1, Audouin, Expl. i, p. 241.

Character.—Zoarium about 1 inch high, tufted, rather spreading, branches slender. Zoœcia elongated. Aperture small, oval; border thin but wide at bottom, not granulated. Three or four marginal spines on the outer side and at the top, and two on the inner side. Fornix with the lamina rounded below and tongue-shaped above, longer than the aperture. Vibraculum small and upright.

Habitat.—Station 135A and C, off Inaccessible and Nightingale Islands, 75 and 110 fathoms.

[Mediterranean ? Savigny.]

Notwithstanding the different form of the fornix in the present species, and in that figured by Savigny, the other characters, and especially the length and slenderness of the zoœcia, and the number and length of the delicate marginal spines, leave little room for doubt that the two forms are identical or very closely allied.

In this form radical tubes may sometimes, though rarely, be seen extending from one branch to another, but not directly transversely as in *Canda*.

(5) *Scrupocellaria securifera*, n. sp. (Pl. XI. fig. 2).

Character.—Zoarium irregularly dichotomous, rather straggling. Aperture large, margin rather thick, a strong, short, conical, oral spine on each side. Fornix hatchet-shaped, expanding towards the outer end, which becomes closely applied to or connate

with the outer border of the aperture (forming a transverse bridge). Œcium large, somewhat flattened in front, much immersed; wall punctured. Vibracularia rather large; flagella simple, setose.

Habitat.—Admiralty Islands.

5. *Canda*, Lamouroux.

Canda, Lamx., Blainv. (pars), d'Orb., Brit. Mus. Cat.
Cellaria (sp.), Lamk.

Character.—Branches biserial, dichotomous, connected by transverse chitinous tubes, inserted at both ends into a vibracularium. No lateral avicularia, and the anterior avicularia, when present, placed on a special median tract or on the summit of the œcia. A vibracularium lodged in a sinus behind; flagellum short, flattened, not toothed. With or without a pedunculate fornix.

By the removal of *Canda reptans* to its proper place under *Scrupocellaria*, where it was classed by Gray, and is retained by Mr. Hincks,[1] the genus *Canda*, as defined by Lamouroux, becomes a very natural one; and as it exhibits features in common with *Caberea*, viz., in the important respect of the membraniporidan type of the front of the zoœcium as well as in the peculiar mode of branching at each bifurcation, as pointed out by Prof. Smitt,[2] it should be placed together with that genus among the Cellulariadæ.

(1) *Canda arachnoides*, Lamouroux.

Canda arachnoides, Lamx., Hist. des Polyp., p. 132, pl. ii. fig. 6; Exp. méth., p. 5, pl. lxiv. figs. 19–22; Blainv., d'Orb., Palæont. Franç., p. 331; Bk., Voy. of Rattles., vol. i. p. 371, Brit. Mus. Cat., vol. i. p. 26, pl. xxxiii.
Cellaria filifera, Lamk., vol. ii. p. 177.

Character.—Front of zoœcium rhomboidal, aperture large, oval, truncated above; the upper margin recedent with a strong spine on each side, the outer much the larger and articulated; margin beaded; lamina covered with minute crystalline granulations. An irregular series of anterior avicularia which are very prominent, with a flexible basal portion and an acute triangular mandible. Œcium subglobose, crowned with a sessile avicularium, and having a broad elliptical membranous area in front.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 to 85 fathoms, sand, shells.

[Bass Strait, 45 fathoms, Voy. of Rattles.; Timor, Péron and Lesueur; New Zealand, Dr. Lyall.]

[1] Brit. Mar. Polyz., vol. i. p. 52.

[2] Florid. Bryoz., pt. i. pp. 15–17. It may be remarked that Prof. Smitt has also noticed that a similar mode of branching or gemmation at each bifurcation, obtains in *Cellularia* (*Scrupocellaria*) *cervicornis*.

The anterior avicularia are sometimes aborted throughout a considerable part of an internode, but never entirely so, and in most cases their site is indicated by a pore-like opening. These organs do not appear to be developed in connection with any individual zoœcium, and they might be regarded perhaps rather as an intermediate series of metamorphosed zoœcia.

(2) *Canda simplex*, n. sp.? (Pl. XIV. fig. 8).

Character.—Zoarium spreading, rather closely reticulate. Frontal area rhomboidal; aperture oval and about half the length of the area; margin not recedent at the top; with a very small spine at each upper angle; margin and lamina thin, indistinctly and finely granulated. No anterior avicularia except on the summit of the oœcia. Oœcia subglobose with a small membranous area in front.

Habitat.—Station 44, lat. 37° 25′ N., long. 71° 40′ W., 1700 fathoms, blue mud.

[Gulf of Mexico, 2 to 15 fathoms.]

In the Challenger collection this form is represented by only one or two minute fragments, in pretty good condition, but which would have been insufficient for its determination, had I not been in possession of specimens of obviously the same form from the Gulf of Mexico, which have enabled me to draw up the above diagnosis. The only difference between the form procured at a depth of 1700 fathoms, and that which had lived at about 12 fathoms, is in the much greater delicacy and slenderness of the former. It is a remarkable circumstance that a second species of *Canda* also occurs in the Gulf of Mexico, which has been described and figured by Prof. Smitt[1] under the not very well chosen name of *Caberea retiformis*. This was procured by Count Pourtales, at a depth of 68 to 270 fathoms. It differs from both the species above described in having a large reniform fornix, and from *Canda arachnoides* in having no avicularia whatever. Of this form I have a good many specimens, procured on John Adam's Bank, North Atlantic, on the voyage of H.M.S. "Herald," which agree in all particulars with Prof. Smitt's description.

6. *Nellia*, Busk.

Salicornaria (pars), Bk., Voy. of Rattles., vol. i. p. 367.
Nellia, Bk., Brit. Mus. Cat., vol. i. p. 18; Smitt; Macgilliv.

Character.—Zoarium articulated, internodes short quadrangular. Zoœcia quadriserial, front flat or convex at bottom. The greater part of the front occupied by a large aperture; border prominent, especially above, smooth and thick. Orifice quite at the summit. Oœcia absent.

[1] Florid. Bryoz., pt. i. p. 16, pl. v. figs. 43–46.

(1) *Nellia oculata*, Busk.

Nellia oculata, Bk., Brit. Mus. Cat., vol. i. p. 18, pl. lxiv. fig. 6, pl. lxv. fig. 4.
" " Smitt, Florid. Bryoz., vol. ii. p. 3, pl. i. figs. 53, 54.
" " Macgilliv., Nat. Hist. Viet., Dec. v. p. 51, pl. xlix. fig. 5.

Character.—Zoarium 2 to 3 inches high, growth tufted; internodes very uniform in length, usually with four or five zoœcia on each face. Outline of front oblong, rounded at top, truncate below. Aperture oval, with a slight constriction above. Two raised papilliform avicularian prominences on each side below the aperture.

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 45 fathoms, green mud. Station 188, lat. 9° 59′ S., long. 139° 42′ E., 28 fathoms, green mud. Station 208, lat. 11° 37′ N., long. 123° 31′ E., 18 fathoms, blue mud. Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 550 fathoms. Off Bahia, 10 to 40 fathoms. Station 151, off Heard Island, 75 fathoms, volcanic mud.

[Torres Strait, Voy. of Rattles.; Coast of Arracan, Walker; Trincomalee, Johnst.; Gulf of Florida, Pourtalès.]

(2) *Nellia simplex*, Busk (Pl. V. fig. 6).

Nellia simplex, Bk., Brit. Mus. Cat., p. 19, pl. lxv. fig. 1.

Habitat.—Station 87, lat. 25° 49′ N., long. 20° 12′ W., 1675 fathoms, rock.

7. *Caberea*, Lamouroux.

Caberea, Lamx., Blainv., d'Orb. (sp.), Gray, Smitt, Busk, Hincks, &c.
Cellaria (pars), Lamk., Audouin.
Flustra and *Cellularia* (pars), Fleming, Johnst.
Crisia (pars), Audouin.
Selbia, *Flabellaria*, Gray.
Canda (sp.), d'Orb.

Character.—Zoarium very variable in dimensions; branches more or less regularly dichotomous; flabellate, cæspitose or radiate. Zoœcia bi-, tri-, or multiserial; anterior face membraniporidan (*i.e.*, showing a large area with an elevated margin, and a membranous aperture of greater or less size); furnished or not with a fornix, and usually having two oral spines on the outer side and two on the inner, one of which arises from or in common with the peduncle of the fornix. An extrangular avicularium to each of the outer zoœcia, and an anterior one on the inner side or both sides of the median zoœcia; the mandible of these avicularia always rounded or obtuse. The back of the branches more or less completely covered with a succession of large interdigitating vibracularia, whose seta is always toothed, and when at rest is received in a groove on the back of the vibracularium. A radical tube enters the under side of each vibracularium, so that the back of the branches is usually completely covered by tubes.

The genus *Caberea*, together with the aberrant form *Amastigia*, constitutes a very peculiar group. Formerly regarded by myself, and, I believe, still considered by all writers (including one of the latest and most careful[1]) as unarticulated, I have now satisfied myself that such is not exactly the case. Though less distinctly divided into segments or internodes, the zoarium in *Caberea* is undoubtedly irregularly segmented, and especially is it the case that at each bifurcation one of the branches of the fork, which may perhaps be regarded as a lateral branch, is always discontinuous, though from the close manner in which the zoœcia are approximated, the joint is often very inconspicuous, and allows of but limited flexion. The segmentation, whatever that character may be worth, which is perhaps not much, except as convenient in an artificial classification, is in any case sufficiently distinct to warrant the collocation of *Caberea* with its natural allies among the Cellulariadæ, and especially of course with *Scrupocellaria*.

Of this genus I am acquainted with seven or eight species, of which, however, not more than three or four can be certainly identified from any published descriptions.

The Challenger collection affords six, of which four appear hitherto to have been undescribed. Of the six species, three occur in the Australian region (including New Zealand), one in what may be termed the Kerguelen region, and two in the south-western Atlantic region.

§ *a. fornicatæ.*

1. *Caberea rostrata*, n. sp. (Pl. XXXII. fig. 4).

? *Selbia zelanica*, Gray, Dieffenb. N. Z., vol. ii. p. 292.

Character.—Zoarium radiate or flabelliform, about 1 inch in diameter; branches long, straight, and close. Zoœcia broadly oval. Area large, with a thin even margin. Aperture large. Fornix short, small, spatulate, with a thick peduncle; blade rather produced upwards; peduncular spine very thick, long; a short, thick, conical, ascending spine on the outer angle. Œcium sub-cucullate; wall entire, smooth. Besides the usual series of small anterior avicularia, occasionally one of enormous size and rostriform projects from the median line directly forwards, having a strong curved acute mandible.

Habitat.—Station 167, lat. 39° 32′ S., long. 171° 48′ E., 150 fathoms, blue mud.

2. *Caberea crassimarginata*, n. sp. (Pl. XI. fig. 1).

Character.—Zoarium rather straggling, regularly dichotomous. Zoœcia biserial. Area elongated elliptical, with a very thick and rounded granular border, leaving an elongated narrow aperture. One or two oral spines on the outer side, and one on the inner (peduncular). Fornix bilobed, the lower lobe much elongated and narrow, the

[1] Hincks, Brit. Mar. Polyz., vol. i. p. 57.

upper broad and truncated above, and often with an ascending process at the outer angle. Anterior avicularia rather large, angular very small and often absent. Oœcium large, lofty, contracted below, surface very smooth and polished.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

(3) *Caberea darwinii*, Busk (Pl. XXXII. fig. 6).

Caberea patagonica, Bk., Brit. Mus. Cat., vol. i. p. 38, pl. xxxviii. (nec *Caberea boryi*).
„ *zelanica*, Bk., Voy. of Rattles., vol. i. p. 378.

Character.—Zoarium expanding, about 1 inch high, flabelliform. Zoœcia elongate. Area large, irregularly oval, wide above, contracted and almost pointed below, the greater part filled in with a finely granular lamina, not continuous across at the top. Aperture open at top and descending about half the length of the area. One or two strong oral spines on the outer side, and one beside the peduncular spine on the inner. Fornix irregularly oval or reniform, blade nearly as large as the aperture. Median avicularium close to and above the peduncle of the fornix, with which it is connate. Oœcium much depressed, bordered. Vibracularia very large.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha, 110 and 150 fathoms. Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand. Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 500 fathoms, hard ground, gravel, shells. Station 149H, I, K, Christmas Harbour, Kerguelen, 45 to 127 fathoms. Off Prince Edward Island, 80 to 150 fathoms. Off Marion Island, 50 to 75 fathoms.

[Cumberland Island, Voy. of Rattles.; New Zealand, Hooker; Strait of Magellan, &c. Darwin.]

It is this form that is represented in the Brit. Mus. Cat., pl. xxxviii., under the name of *Cabarea boryi* (on the plate, *Cabarea patagonica*), but as it is by no means clear (though not improbable) that it is identical with M. d'Orbigny's *Canda* (*Caberea*) *patagonica*, Voy. en Amér. Mérid., p. 9, pl. ii. figs. 5–9, I have thought it better not to adopt that appellation, which may nevertheless turn out to be applicable; and instead of the term *zelanica* which I also at one time applied to it (under the supposition that it was the *Selbia zelanica* of Gray), I have given it the name of the illustrious naturalist to whom I was indebted for the first specimens that came under my notice. The *Selbia zelanica* of Dr. Gray I now propose to term *Caberea lyallii*, having fully satisfied myself that that New Zealand species is quite distinct from *Caberea boryi*, under which appellation both I and others have confounded two or three quite distinct species. So far as I know at present, the true *Caberea boryi* of Audouin is confined to the Mediterranean and Atlantic regions, as far north as our own coast, and as far south, in all probability, as the Cape (Algoa Bay).

(4) *Caberea rudis*, Busk.

Caberea rudis, Bk., Brit. Mus. Cat., vol. i. p. 38, pl. xlvi.; pl. xxxvi. figs. 1, 2; Voy. of Rattles., vol. i. p. 377.

Character.—Zoarium broad, frondose, 2 or 3 inches high; branches disposed in the same plane, flat, thick, and about $\frac{1}{8}$th inch wide. Zoœcia (viewed behind) rhomboidal. Aperture oval, margin much thickened; a strong oral spine on each side in the central cells; three strong and long spines on the outer side, and one on the inner in the marginal cells. Fornix spatulate, wide, with a very broad peduncle. Two small avicularia in front below the aperture in the central cells, and a single large avicularium below the aperture in the marginal ones. Vibracula slender, with very delicate walls; seta of moderate size, serrated.

Habitat.—Station 161, off entrance to Port Philip, 33 fathoms, sand.

[Bass Strait, Voy. of Rattles.]

In the Brit. Mus. Cat. the seta is erroneously described as not serrated.

(5) *Caberea minima*, n. sp. (Pl. XXXII. fig. 5).

Character.—Zoarium very small, about $\frac{1}{2}$ inch wide, fan-shaped; branches short, irregularly dichotomous. Zoœcia, area nearly circular. Aperture almost as large as the area, entirely open above; lamina smooth and very delicate. Fornix with a subcordate or circular blade, apparently articulated to a very wide and thick peduncle, and standing some distance in front of the aperture. Peduncular spine very strong; median avicularium arising immediately above the base of the peduncle.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel.

[Falkland Islands.]

§ β. *apertæ.*

(6) *Caberea lata*, Busk (Pl. XI. fig. 3).

Caberea lata, Bk., Voy. of Rattles., vol. i. p. 378; Brit. Mus. Cat., p. 39, pl. xlvii.

Character.—Zoarium flabellate, branches rather wide, broadly truncate. Zoœcia, area occupying the entire front, margin thin and smooth. Aperture elliptical, large. A small avicularium (often aborted) at each lower angle of the aperture. Often a short spine at the upper and outer angle of the lateral cells, each of which is also furnished with a rather large extrangular avicularium. Vibracularia very long, closely approximated, and very

deeply grooved; setæ long and strong. Radical tubes forming a dense elevated keel in the middle of the branch behind (none on the sides).

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 45 fathoms, green mud. Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

[Australia, Voy. of Rattles., New Zealand, Hooker.]

This species varies a good deal; the small anterior avicularium is sometimes absent or only rudimentary, and in some cases the lateral extrangular avicularium is very minute or inconspicuous, whilst in others it may attain a very considerable size. When the growth occurs in the biserial form it would be easy to confound it with *Caberea hookeri*.

Family VI. Bicellariadæ.

Bicellariadæ, Bk., Brit. Mus. Cat., vol. i. p. 41; Voy. of Rattles., vol. i. p. 373.
Bicellariæ, Smitt.
Bugulidæ, Gray.
Bicellariidæ, Bk., Crag. Polyz. (pars); Hincks.
Acamarchisidæ, d'Orb.

Character.—Zoarium continuous, erect, phytoid, divided into ligulate, bi-multiserial branches; affixed by radical fibres, and sometimes supported on a long chitinous tubular stem, which represents a modified radical tube. Avicularia, when present, pedunculate capitate, articulated or not. Zoœcia with a wide oblique aperture, all facing in the same direction.

The Family here contains the following genera:—

1. *Bicellaria*, Blainville.
   - (1) *Bicellaria navicularis*, n. sp. (Pl. VII. fig. 2).
   - (2) *Bicellaria pectogemma*, Goldstein (Pl. VII. fig. 1).
   - (3) *Bicellaria infundibulata*, n. sp. (Pl. VI. fig. 2).
   - (4) *Bicellaria bella*, n. sp. (Pl. VI. fig. 3).
   - (5) *Bicellaria moluccensis*, n. sp. (Pl. VI. fig. 4).
   - (6) *Bicellaria glabra* (Hincks) (Pl. VI. fig. 1).
   - (7) *Bicellaria macilenta*, n. sp. (Pl. XXXII. fig. 1).

2. *Bugula*, Oken.

   § α.
   - (1) *Bugula versicolor*, n. sp. (Pl. III. fig. 4).
   - (2) *Bugula leontodon*, n. sp. (Pl. X. fig. 3).
   - (3) *Bugula sinuosa*, n. sp. (Pl. X. fig. 2).
   - (4) *Bugula mirabilis*, n. sp. (Pl. X. fig. 1).

§ β.

(5) *Bugula reticulata*, n. sp. (Pl. VIII. fig. 3).

(6) *Bugula bicornis*, n. sp. (Pl. IX. fig. 1).

§ γ.

(7) *Bugula margaritifera*, n. sp. (Pl. VIII. fig. 4).

§ δ.

(8) *Bugula neritina* (Linn).

(9) *Bugula longissima*, n. sp. (Pl. XXXI. fig. 7).

3. *Kinetoskias*, Koren and Danielssen.

(1) *Kinetoskias cyathus* (Wyv. Thoms.) (Pl. VIII. fig. 1).

(2) *Kinetoskias pocillum*, n. sp. (Pl. VIII. fig. 2).

4. *Ichthyaria*, n. gen.

Ichthyaria oculata, n. sp. (Pl. XIII. fig. 7).

1. *Bicellaria*, Blainville.

Bicellaria, Blainv., Gray, Johnst., Brit. Mus. Cat., Hincks, &c.
Cellularia (pars), Fleming, Pallas.
Cellaria (sp.), Solander, Lamx.
Crisia (pars), Lamx.
Bugula (pars), Oken.
Stirparia, sp., Goldst.; Hincks.

Character.—Zoœcia turbinate or subturbinate, biserial, the two series more or less disjunct. Aperture large, directed obliquely upwards. Avicularia when present usually pedunculate and capitate or trumpet-shaped; rarely sessile, not articulated, and placed either on the anterior or posterior aspect.

(1) *Bicellaria navicularis*, n. sp. (Pl. VII. fig. 2).

Character.—Aperture boat-shaped, the wider end outwards; a small funnel-shaped, shortly pedunculate avicularium at the inner end, in front of the aperture. A long digitiform process, produced from the summit of the zoœcium below the border of the aperture, from which arise four to eight (usually six) long delicate curved spines, articulated chiefly along the posterior side of the digitiform process. Oœcium (fig. 2*b*) rounded, depressed, cucullate, recumbent, at the outer border of the aperture. A small solitary dorsal spine.

Habitat.—Station 122, Barra Grande, Brazil, lat. 9° 5′ S., long. 34° 50′ W., 32 to 400 fathoms, red mud. Station 332, lat. 37° 29′ S., long. 27° 31′ W., 2200 fathoms, Globigerina ooze.

The digitiform process, which forms such a striking character in this species, is represented in *Bicellaria tuba* (Brit. Mus. Cat., p. 42, pl. xxxi.) by a smaller process of the same kind. It is a simple continuation of the zoœcial cavity, and the secondary spines arising from it are articulated at the base. The most marked peculiarity in *Bicellaria naviculariis* is the small funnel-shaped avicularium placed in front of the lower edge of the aperture; not unfrequently there is also a second avicularium of the same kind in front of the upper edge of the aperture. A specimen from 400 fathoms, prepared by Mr. Moseley, has the zoœcia of much larger size than the others.

(2) *Bicellaria pectogemma*, Goldstein (Pl. VII. fig. 1).

Bicellaria pectogemma, Goldst., Proc. Roy. Soc. Vict., June 9, 1881, p. 4, pl. i. figs. 2–2*a*.

Character.—Aperture oval, with a much raised, thin, spatulate margin. Zoœcium attenuated into a very long slender tube. A series of four to six long, curved, very slender spines rising from the back and outer side of the zoœcium, and a small dorsal spine near the rachis. Oœcium large, rounded, quite recumbent, placed at the outer end of the aperture. Avicularia very various in size, but all long, trumpet-shaped, arising from the back of the zoœcia.

Habitat.—Station 145, lat. 46° 48′ S., long 37° 49′ E., 150 to 310 fathoms. Station 150, lat. 52° 4′ S., long. 71° 22′ E., 150 fathoms, coarse gravel. Station 151, off Heard Island, 75 fathoms, volcanic mud.

At first sight resembling *Bicellaria tuba*, Brit. Mus. Cat., p. 42, pl. xxxi., *Bicellaria pectogemma* differs in the more elongated form of the aperture and the absence of the short, digitiform, spiniferous process possessed by the former. The avicularia are alike in both. It should be remarked that the specimens from the two latter localities given above, and from shallower water, are considerably smaller than those from Station 145.

(3) *Bicellaria infundibulata*, n. sp. (Pl. VI. fig. 2).

Character.—Zoœcia infundibuliform. Aperture rounded, expanding outwards; outer border obtusely angular and arched in the middle; one to three long, slender, articulated spines above or behind the aperture (sometimes absent); a minute dorsal spine near the rachis. Oœcia globose, recumbent, placed beyond the aperture of special zoœcia, which arise by a long tubular prolongation from the back of one of the others, from the same spot from which the avicularia spring, and which may doubtless be a modification of the same process. Avicularia of two kinds: one (rare) long, slender, trumpet-shaped, the other capitate, shortly pedunculate; both articulated on the dorsum of a zoœcium.

Habitat.—Station 147, lat. 46° 16′ S., long. 48° 27′ E., 1600 fathoms, Diatom ooze. Station 156, lat. 62° 26′ S., long. 95° 44′ E., 1975 fathoms, Diatom ooze.

The trumpet-shaped avicularia are but rarely developed; they differ from those on *Bicellaria spatulata* in their much smaller size and the more oblique truncation of the terminal surface; all the avicularia have a peculiar vertical posture. The specimens from Station 156 differ in some respects from the others; they are extremely soft and flaccid, containing apparently but very little calcareous matter; and the zoœcia are usually without any spines or with a very short and blunt one behind; the angularity, moreover, of the outer border of the aperture is more marked, and the dorsal avicularia rather larger. This may be regarded as a variety, *flaccida*. The size of the zoœcia is much greater in the var. *flaccida*, in which they appear to attain the greatest dimensions as yet noticed in the genus (0″·06 × ·02), the former dimension being the length of the tubular portion between the two joints, and the latter being the width of the body.

(4) *Bicellaria bella*, n. sp. (Pl. VI. fig. 3).

Character.—Zoarium about 1½ to 2 inches high; branches irregularly forked, with short lateral feathered secondary branches. Zoœcia tubular, very long, and slender below, suddenly widely expanding above with an oblique, irregularly angular aperture, which is prolonged a short way at the outer angle into a digitiform process which projects in front and supports usually six very long curved spines; and on the back of the zoœcium is a row of six to eight also very long spines curving forwards. A small infundibuliform, shortly pedunculate, erect, avicularium (fig. 3*b*) is articulated close below the inner border of the aperture in front; sometimes a second avicularium of the same kind is found on the front of the same zoœcium, and occasionally one of rather smaller size may be seen attached to the side of the digitiform process near its point.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground.

(5) *Bicellaria moluccensis*, n. sp. (Pl. VI. fig. 4).

Character.—Zoarium 3 or 4 inches high, branches long, straight, forked at an acute angle, feathered. Zoœcia tubular, length between the nodes about 0″·03; body of zoœcia about 0″·02 × ·01 to ·015. Aperture ovate, expanded towards the upper part; upper border wavy. A digital process projecting rather in front, supporting four or five long, curved spines. A long articulated spine behind towards the outer end of the zoœcium, and a small, upright one near the inner end. A large, circular cup or disc in the middle of the dorsum, from which springs, with a much contracted base, a long tubiform avicularium, of nearly equal calibre throughout, and with the wall very faintly ringed.

Oœcium lofty, helmet-shaped, fixed at the upper border of the aperture, and with a slightly thickened and everted lip.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground.

One great peculiarity of this species is the invariable origin of the avicularium from the middle of a cupped disc on the dorsum of the zoœcium; close to the base the tube is very much and suddenly constricted, but there is no true articulation; from this part to the extremity the tube is of very equal diameter, not gradually enlarging as in *Bicellaria spatulata*, and the terminal portion is not very much expanded. The rostral portion forms an oval cup, with a thin membranous border, and the mandible is obtuse and fringed with a very thin membrane, representing more the lid of a trap than an organ for prehension, as it has no incurved acute denticle at the end, such as is usually present. The internal arrangement of the avicularium is however exactly like that in the avicularium of *Bicellaria pectogemma*, Pl. VII. fig. 1.

(6) *Bicellaria glabra*, Hincks (sp.) (Pl. VI. fig. 1).

Stirparia glabra, Hincks, Ann. and Mag. Nat. Hist., ser. v. vol. xi. p. 195, 1883.

Character.—Zoœcia disposed in a short, dense, sub-triangular spike, supported by a very long, slender, tubular, jointed, chitinous stem, which bifurcates irregularly. Zoœcia infundibuliform, shortly tubular below. Aperture sub-triangular. Avicularia small, pedunculate, sparsely distributed on the front of some of the zoœcia, close below the aperture. The two or three lowest zoœcia in each capitulum have from five to seven reclinate spines on each side. The upper ones usually only a single ascending spine on each side. Oœcia (seen only on a few of the lower zoœcia) globose, with an acute keel in front.

Habitat.—Off Bahia, 10 to 12 fathoms.

[Western Australia, Miss Gore.]

Only a single, not very perfect, specimen of this very curious form occurs in the collection, having apparently been selected and placed aside, in a small separate tube, from the rest of the gathering procured in the same locality.

The curious peduncle is very distinctly divided into numerous internodes of irregular lengths, and is probably of the same nature as that of *Kinetoskias cyathus*.[1]

(7) *Bicellaria macilenta*, n. sp. (Pl. XXXII. fig. 1).

Character.—Zoarium about 1 to 2 inches high, of tufted growth; branches short, feathered. Zoœcia, body narrow, subtubular, very widely expanded at the

[1] Since the above was in type, Mr. Hincks has described, apparently, the same form under the name of *Stirparia glabra*, and gives a full account of the peculiar structure on the zoarium and its stem from better materials than those at my command.

aperture, which is more or less triangular or sub-rhomboidal; the outer angle running into the digital process, which is continued from the external angle, and supports on the upper side four or five long curved articulated spines. Two long articulated dorsal spines near the upper part of the zoœcium and a slenderer one near the rachis. No avicularia. The median cell at a bifurcation has a triangular aperture, the upper border arched in the middle, and no digital process. Oœcium helmet-shaped, with a slightly thickened border.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground.

Brought up in the same haul together with *Bicellaria bella* and *Bicellaria moluccensis*, the present form is indistinguishable, by the naked eye, from the former of these species, and for some time I was inclined to regard it as a variety; but notwithstanding the several points in which they show strong similarity, in all important respects they differ very widely. I may add that the comparison has been made with abundance of specimens, and the distinction appears to me to rest on ample grounds.

The chief points of resemblance may be stated to be:—

1. The general habit, which is precisely the same, including the mode in which the numerous spines arch over the front of the branches, though these appendages are less numerous in *Bicellaria macilenta* than in *Bicellaria bella*.

2. The outer angle of the aperture is prolonged into the base of the digital process; but in *Bicellaria macilenta* this prolongation is more extensive.

3. The curious angular curvatures of what may be termed the rachis, which forms an abrupt angle at the base of the body of each zoarium.

The similarity in form of the oœcia might also be cited; but as that organ presents exactly the same appearance in several other species, it is not a distinctive character of any value in the present case.

The differences are:—

1. The form of the body of the zoœcium, which in *Bicellaria macilenta* is very much narrower and almost cylindrical.

2. The absence of a digital process in the median zoœcium at a bifurcation, whilst in *Bicellaria bella* that, or rather it may be said, the two median zoœcia, in the same situation, are furnished with a digital process, projecting directly in front, owing to the circumstance that the zoœcia in question look sideways and not directly in front, as in *Bicellaria macilenta*.

3. The total absence of avicularia of any kind in *Bicellaria macilenta*.

2. *Bugula*, Oken.

Bugula, Oken, Busk, Smitt, Gray (sp.), Smitt, Hincks, &c.
Acamarchis, Lamx., Blainv., d'Orb. (sp.).
Crisia (sp.), Lamx.

Cellularia (sp.), Pallas, Johnst., &c.
Cellaria (sp.), Ell. and Soland.
Bugulina, Crisalaria, Flabellaria, Gray.
Avicella, v. Bened.
Ornithopora, Ornithoporina, Cellularia (pars), d'Orb.
Bicellaria (sp.), v. Bened.
Halophila (sp.), Bk.

Character.—Zoœcia bi- or multiserial, closely contiguous and united, arising in continuous series each from the back of the subjacent one. Aperture partial or entire. Avicularia when present always on the anterior aspect of the zoœcia.

In order to include several of the species in the present collection, and to avoid the creation of one or more new genera, I have thought it better in this catalogue so to modify the definition of *Bugula* as to admit of these, for the most part, new forms being placed in it. And this wider definition, resting mainly as respects the distinction of *Bugula* from *Bicellaria* upon the mode of gemmation and inter-connection of the zoœcia, allows of *Halophila* being included under it, which in fact differs in no essential particular from such an unarmed form, for instance, as *Bugula neritina*.

The group, however, as thus made up, includes several apparently distinct types, which will probably at some time be thought of at least sub-generic value.

To indicate what is meant by these sub-generic or generic groups, I venture to propose the following scheme.

§ α. Those species in which in one part of the zoarium the branches are biserial and in another tri-, or quadri-serial, the intermediate series only including the fertile zoœcia, the oœcia being lodged within the superjacent zoœcium, whilst the avicularium is subsessile at the bottom of the zoœcium in front.

1. *Bugula versicolor*, n. sp. (Pl. III. fig. 4).
2. *Bugula leontodon*, n. sp. (Pl. X. fig. 3).
3. *Bugula sinuosa*, n. sp. (Pl. X. fig. 2).
4. *Bugula mirabilis*, n. sp. (Pl. X. fig. 1).

§ β. Those in which the zoœcia are much attenuated downwards, and the avicularia are supported on very long, flexible, and probably contractile pedicels.

5. *Bugula reticulata*, n. sp. (Pl. VIII. fig. 3).
6. *Bugula bicornis*, n. sp. (Pl. IX. fig. 1).

§ γ. Those in which the zoœcia are usually oblong and little or not at all attenuated downwards, and have shortly pedunculate avicularia, usually articulated to the margin of the aperture, such as *Bicellaria flabellata, turbinata, avicularia, plumosa*, &c.

7. *Bugula margaritifera*, n. sp. (Pl. VIII. fig. 4).

§ δ. Those in which the zoœcia are wholly unarmed, such as *Bugula* (*Halophila*) *johnstoniæ*.

8. *Bugula neritina* (Linné).
9. *Bugula* (*Halophila*) *longissima*, n. sp. (Pl. XXXI. fig. 7).

It may also be observed that the first and second of these groups consist almost exclusively of very deep water forms, the shallowest being 150 fathoms for *Bugula sinuosa*, whilst the depths from which the other species, included in those groups, were brought up was on the average not less than 2000 fathoms. They would appear therefore to constitute a distinctively abyssal type.

The Challenger collection contributes eight new species to this genus, of which perhaps from sixteen to twenty were previously known.

Of these, two occurred in the South Atlantic region, two in the Kerguelen, or South Indian region, two in the North Atlantic, and one in both the South Atlantic and South Pacific regions.

The least depth from which any one of them was brought up is 60–75 fathoms; the depths from which all the rest were procured varying from 400 to 2500 fathoms; and as the species from 600 fathoms occurred also in the South Pacific, at a depth of 2160 fathoms, they may, as above said, be regarded as specially deep water forms; on which account, doubtless, they have hitherto escaped notice.

Though none appear to have been met with in the Australian region, *Bugula bicornis* occurred but very little to the west of it. The group affords a striking instance of the comparatively large size and free growth, and at the same time of the extremely delicate structure, characteristic it may almost be said of the Polyzoa that live in the tranquil depths of the ocean.

(1) *Bugula versicolor*, n. sp. (Pl. III. fig. 4).

Character.—Zoarium about 2 inches high; coloured blue and purple;[1] forked, and from the upper side only of each branch straight secondary branches arise in the same plane and parallel with each other. (Candelabriform). Zoœcia bi- or tri- serial, oblong, nearly straight on the outer side, sinuated on the inner. Aperture entire, margin thick, smooth. Oœcia globose, usually seated on one of the median zoœcia in the triserial branches, and enclosed within the superjacent zoœcium, which is widely dilated for its reception.

Habitat.—Station 23, Sombrero Island, 450 fathoms, Globigerina ooze. Station 122, lat. 9° 5′ S., long. 34° 50′ W., 350 fathoms, red mud.

[1] This colour has remained permanent in a wet preparation up to the present time (1884).

(2) *Bugula leontodon*, n. sp. (Pl. X. fig. 3).

Character.—Zoarium composed of stout, straight, long furcate branches, several inches high. Zoœcia bi- or tri-serial, elongated ovate, constricted at the base, but not tubular. Aperture occupying the entire front. Two or three strong curved tooth-like processes project inwards from one or both sides of the aperture. Avicularia subsessile, subglobose, seated on the apertural membrane near the lower border.

Habitat.—Station 3, lat. 25° 45′ N., long. 20° 14′ W., 1525 fathoms, hard ground.

(3) *Bugula sinuosa*, n. sp. (Pl. X. fig. 2).

Character.—Zoarium several inches high; branches strong, forked, spreading, straight, bi- or quadri- serial. Zoœcia elongated fusiform (viewed behind), constricted quite at their origin but not tubular. Aperture occupying the whole of the front. A blunt spinous process at the upper angle of each of the zoœcia in the intermediate series, and only on the outer angle in the lateral. Avicularia subsessile, subglobose, situated on the outer side quite at the bottom of the lateral zoœcia only.

Habitat.—Prince Edward Island, 80 to 150 fathoms.

Though closely allied to *Bugula mirabilis*, the differences between the two appear to be quite sufficient to justify their being regarded as specifically distinct. A single specimen only occurs in the collection.

(4) *Bugula mirabilis*, n. sp. (Pl. X. fig. 1).

Character.—Zoarium several inches high, spreading, composed of thick, straight, bifurcating branches. Zoœcia bi- or tri-serial, elongated, narrow, of very uniform breadth, except quite at the bottom. The aperture occupies four-fifths of the length, and is pointed at the bottom; the upper border rounded and quite simple. Avicularia subsessile, pyriform, with a very short peduncle articulated to the front of the zoœcium, immediately below the aperture, and slightly to one side. The fertile zoœcia form an intermediate or median series, in which they alternate with those in the lateral series, which are thus in pairs on the same level.

Habitat.—Station 89, lat. 22° 18′ N., long. 22° 2′ W., 2400 fathoms, Globigerina ooze.

A very remarkable dimorphous form, as it may be termed. The growth commences with a stem, composed of a *fasciculus* of radical fibres, and the zoarium at the lower part is constituted of slender divaricate biserial branches, whilst in the upper portions of the growth the branches are much thicker and triserial.

Whether all the zoœcia in the middle series are fertile is not quite certain, but as it is only in some of these that the oœcia are developed, it may be supposed that all may

in time be similarly provided. The avicularia resemble those of *Bugula margaritifera* in their subsessile mode of articulation, but differ in their pyriform shape, larger size, and position on the front of the zoœcium below the aperture, and not upon the margin as in that species.

§ β.

(5) *Bugula reticulata*, n. sp. (Pl. VIII. fig. 3).

Character.—Zoarium composed of long, straggling, distant branches, connected by transverse, delicate, calcified, jointed tubes, which appear to issue from the upper and back part of a zoœcium in one of two contiguous branches, and to attach themselves to one in the other branch, either by a discoid expansion of the tube or by tendril-like claspers. Zoœcia elongated, subtubular below. The frontal aperture occupies from one-half to two-thirds of the length. Either with or without a marginal spine at each upper angle. A pedunculated avicularium of small size is articulated by a long flexible pedicel to a rounded opening close below the aperture in front. Oœcia large, lofty cucullate.

Habitat.—Station 147, lat. 46° 16′ S., long. 48° 27′ E., 1600 fathoms, Diatom ooze. Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand. Station 299, lat. 33° 31′ S., long. 74° 43′ W., 2160 fathoms, blue mud. Station 303, lat. 45° 31′ S., long. 78° 9′ W., 1325 fathoms, Globigerina ooze.

Var. α, *unicornis* (Pl. IX. fig. 2).

Many of the zoœcia have a tubular cylindrical spine arising from the back near the top.

Habitat.—Station 101, lat. 5° 48′ N., long. 14° 20′ W., 2500 fathoms, blue mud. Station 106, lat. 1° 47′ N., long. 24° 26′ W., 1850 fathoms, Globigerina ooze. Station 104, lat. 2° 25′ N., long. 20° 1′ W., 2500 fathoms, Globigerina ooze. Station 68, lat. 38° 3′ N., long. 39° 19′ W., 2175 fathoms, Globigerina ooze.

The peculiar dorsal hollow spine is probably only a modified or undeveloped connecting tube. A pedunculate avicularium, exactly like those seated on the zoœcia, may sometimes be seen on one of the transverse connecting tubes above described.

(6) *Bugula bicornis*, n. sp. (Pl. IX. fig. 1).

Character.—Zoarium several inches high, composed of very long branches. Zoœcia elongated, wide above and subtubular below, each arising from nearly the middle of the back of the preceding one. Aperture elliptical, occupying about two-thirds of the front; the sides produced at each upper angle into a large hollow, conical horn. Two avicularia

with very long tubular pedicels arise from the front of each zoœcium; one much larger than the other, and of a different form, arises low down from the tubular prolongation of the cell, and the other much smaller from the front, close below the aperture. Numerous slender radical or clasping tubes arise from the backs of the zoœcia.

Habitat.—Station 157, lat. 53° 55′ S., long. 108° 35′ E., 1950 fathoms, Diatom ooze.

The structure of this magnificent species is of extreme delicacy, so much so indeed that it is difficult to discern the transition from the diaphanous membrane which covers in the frontal aperture to the cell-wall proper; both textures are as transparent as glass and excessively thin. The avicularia are of two distinct kinds, one of each being attached normally to every zoœcium. The larger kind is elongated, and when the mandible is thrown back a digitiform process protrudes (fig. 1*e*). This form of avicularium is supported on a very long jointed, tubular, flexible, peduncle, which in the living state is probably cylindrical, but, perhaps from the action of the alcohol, it usually appears flattened and often thrown into regular zig-zag folds, leading to the suspicion that it may contain a contractile element. The wall of the peduncle of both kinds of avicularia is very finely ringed. The numerous jointed tubular threads proceeding from the back of the zoœcia appear to be of the same nature as those which connect the branches in *Bicellaria reticulata*, from which they differ, however, in their smaller diameter, and in their never, apparently, acting as connectives. Each of these tubes terminates, as it would seem, in a very delicate, but still jointed or segmented hollow filament, upon which may often be seen Globigerina shells and other Foraminifera hanging. It may be supposed, therefore, that the zoarium in its natural state lies prostrate on the ooze, and is affixed by numerous points as well as by a central peduncle.

The polypide has eighteen or twenty tentacles, and appears to be capable of being entirely protruded to a considerable distance; though how this protrusion is effected is very difficult of explanation.

§ γ.

(7) *Bugula margaritifera*, n. sp. (Pl. VIII. fig. 4).

Character.—Zoarium 3 to 4 inches high, lax and straggling. Zoœcia very long and narrow, entirely open in front. A very small spinous process at each upper angle. A subglobose, almost sessile avicularium articulated on the outer border of each zoœcium, close to the bottom.

Habitat.—Station 323, lat. 35° 39′ S., long. 50° 47′ W., 1900 fathoms, blue mud. Station 332, lat. 37° 29′ S., long. 27° 31′ W., 2200 fathoms, Globigerina ooze.

A very interesting form, as coming from such an extreme depth. Its structure, as in most of the abyssal forms, is very delicate and transparent, and it is rooted by an infinite number of radical fibres, each attached to a dead Globigerina shell or similar small particle.

At first sight the avicularia appear to be sessile, but they are in reality articulated to the outer edge of the frontal aperture.

§ δ.

(8) *Bugula neritina*, Linné (sp.).[1]

"Remarkable Coralline," Ellis, Coral., p. 35.
Sertularia neritina, Linn., Dell. Chiaje, Esper.
Cellularia neritina, Pallas, Fleming, Johnst., &c.
„ „ Bk., Ann. and Mag. Nat. Hist., ser. 2, vol. vii. pl. viii. figs. 5, 6, 7.
Cellaria neritina, Solander, Lamk., Esper., t. xiii. fig. 123.
Bugula neritina, Oken, Gray (pars), Bk., Brit. Mus. Cat.
Acamarchis neritina, Lamx., Risso, Blainv.
„ „ d'Orb., Ann. des Sci. Nat., 1851, p. 313.

Character.—Zoœcia rhomboidal, elongated, truncate above, with projecting angles. Noavicularia.

Habitat.—Station 36, off Bermudas, 30 fathoms, coral.

[Britain, Scarborough Bean, Falmouth, F. W. Smith; New Zealand, Hooker Lyall, Darwin; Auckland Island, Hooker; Australia, Voy. of Rattles.; Rio de Janeiro, Lyall; North America, Ellis; Bay of Honduras, Shadbolt; Adriatic, Heller; Gulf of Spezzia, Tasmania, Miss Gatty.]

(9) *Bugula longissima*, n. sp. (Pl. XXXI. fig. 7).

Character.—Zoarium of long, straggling, lax growth, very irregularly branched. Zoœcia usually produced downwards into a long tubular portion, a constriction being placed at the junction of the dilated upper portion and the tubular, and a second constriction near the lower end. Aperture oblong, occupying the entire front of the dilated portion; a conical process on the upper and outer angle. Oœcium globose, acuminate, surface engine-turned.

Habitat.—Station 149D, Royal Sound, Kerguelen, 28 fathoms. Station 151, off Heard Island, 75 fathoms, volcanic mud.

Remarkable amongst its congeners, of which it is probably most closely allied to *Bugula* (*Halophila*) *johnstoniæ*, Gray, by the long tubular prolongation of the zoœcium downwards. In fact the appearance of that portion with its constrictions above and below indicates that it is homologous in all probability with a segment of a radical tube; as which, I should be inclined to regard it, in accordance with what has been remarked, more particularly with reference to *Bicellaria macilenta* (p. 35).

[1] Mr. Hincks does not include this species in his list of British Marine Polyzoa; and its occurrence in the two localities cited has probably been accidental.

There is a single, large, oval, interzoœcial disc in the wall between the zoœcia, where they are in apposition.

3. *Kinetoskias*, Koren and Daniellsen.

Bugula, sp., Smitt.
Naresia, Wyv. Thoms.

Character.—Zoarium composed of bifurcating branches radiating from a common centre and forming a wide infundibuliform vase. The lower part of the branches united by a delicate membrane, and the whole supported on a chitinous cylindrical stem, which is rooted by radical *fibrillæ*. Avicularia marginal, shortly pedunculate. At the bottom of each zoœcium a special muscle for bending the zoœcium forwards.

In 1867, D. C. Daniellsen[1] described two new forms of Polyzoa found by him in Nordland and Finmark, which he proposed to refer to a new genus—*Kinetoskias*, from the circumstance that the branches appeared to have some power of motion in curling their extremities outwards. And in the same year, a month or two later, Prof. Smitt,[2] apparently unaware that a new name had been proposed, described one of the forms noticed by Daniellsen, under the name of *Bugula umbella*, procured from Wijde Bay, Spitzbergen.

On the 30th January 1873, on the Challenger Expedition, a specimen of large size, closely allied to, if not identical with one of those described by Koren and Daniellsen was described and figured by Sir C. W. Thomson,[3] under the name of *Naresia cyathus*. This specimen was procured from a depth of 1525 fathoms, in the North Atlantic; and a second specimen of the same form but of smaller size was procured on the 2nd March 1876, in the South Atlantic, from a depth of 2650 fathoms. Other specimens of a closely allied but quite distinct form were obtained on the 10th of September 1875, also in the South Atlantic, from a depth of from 32 to 400 fathoms, and again on the 14th December, in lat. 33° 31′ S., and long. 74° 43′ W., from a depth of 2160 fathoms.

The two original forms, first noticed by M. Daniellsen, have been since more fully described and figured by himself and M. Koren.[4]

We are thus made acquainted with what appear to be four distinct species of this very peculiar type, viz :—

1. *Kinetoskias smittii*, Koren and Daniellsen.

Bugula smittii, Sars.

[1] *Förhandl. Vidensk. Selsk.*, Christiania, 1867, p. 23.
[2] Kritisk. Förteckn. Skandinav. Hafs-Bryozoer, *Öfversigt k. Vetensk.-Akad. Förhandl.*, 1867, pp. 292–353, pl. xix. figs. 28, 31.
[3] *Nature*, vol. i. p. 387.
[4] Fauna littoralis Norvegiæ, part iii., 1877, p. 104, pl. iii. figs. 12–14.

2. *Kinetoskias arborescens*, Daniellsen.
Kinetoskias arborescens, K. and D.
Bugula umbella, Smitt.

3. *Kinetoskias cyathus*, Wyv. Thoms. (sp.)
Naresia cyathus, Wyv. Thoms.
? *Kinetoskias smittii*, K. and D.

4. *Kinetoskias pocillum*, Busk.

Of the above, two have come under my observation from the Challenger collection, viz. :—*Kinetoskias cyathus*, Wyv. Thoms., and *Kinetoskias pocillum*, Busk.[1]

(1) *Kinetoskias cyathus*, Wyv. Thoms. (sp.) (Pl. VIII. fig. 1).

Naresia cyathus, Wyv. Thoms., Voyage of the Challenger, The Atlantic, vol. i. p. 142, 1877.

Character.—Zoœcia about 0″·045 by 0″·02; oblong, the outer border somewhat hollowed, and towards the lower part presenting a sort of step on which the avicularium is articulated, and furnished with a special muscle (Pl. VIII. fig. 1*a*). Aperture entire, or very nearly so. The upper and inner angle rounded off, and the external produced into a short pointed conical process. Posteriorly the zoœcium (fig. 1*b*) is very convex, and the surface perfectly smooth. The outline is much the same as in front; the outer border is acute, and the inner rounded. Oœcia of large size, attached to the middle of the summit of the zoœcium in front, and projecting forwards in the form of a wide shallow hood.

Avicularia about 0″·02 long, by 0″·006 wide, the mandible measuring 0″·01, and being much curved.

Habitat.—Station VI., lat. 36° 23′ N., long. 11° 18′ W., 1525 fathoms; Globigerina ooze. Station 325, lat. 36° 44′ S., long. 46° 16′ W., 2650 fathoms; blue mud.

Messrs. Koren and Daniellsen are inclined to consider that their *Kinetoskias smittii* is identical with *Kinetoskias cyathus;* but so far as I am able to judge from their detailed description and figures, this can hardly be the case. The form and size of the zoœcia, and of the avicularia and oœcia, undoubtedly appear to correspond with those of *Kinetoskias cyathus;* but the general aspect of the zoarium in the two cases is utterly dissimilar.

In this particular, however, it should be remarked that the natural size figure given in their pl. iii. does not at all correspond with the description in the text. But in *Kinetoskias cyathus* there are no transverse rugæ on the back of the zoœcium, and the avicularium in *Kinetoskias smittii* is apparently attached above the middle of the outer border, whilst in *Kinetoskias cyathus* it arises from a distinct step-like process very near the bottom.

[1] In the *Quart. Journ. Micr. Sci.*, N.S., vol. xxi. Jan. 1881, I have given an account of the structure of this very remarkable genus, the principal points connected with which had however already been noticed by Messrs. Koren and Daniellsen, and by Professor Smitt, who had left very little new to be said on the subject.

On these grounds there does not appear to be any sufficient reason to regard *Kinetoskias smittii* and *Kinetoskias cyathus* as specifically the same.

(2) *Kinetoskias pocillum*, Busk (Pl. VIII. fig. 2).

Kinetoskias pocillum, Bk., Quart. Journ. Micr. Soc., vol. xxi., N. S., p. 7, pl. i. figs. 2, 5, 1881.

Character.—Zoarium like that of *Kinetoskias cyathus*, but much smaller. Zoœcia rather contracted at the bottom, rounded above, and without any angular process. Avicularium (fig. 2*d*) affixed to the outer border about the middle. Posteriorly convex (fig. 2*b*), quite smooth, outline irregularly oblong, the outer border being sharp and the inner rounded and gibbous. Oœcia smaller than in *Kinetoskias cyathus*, cucullate, the opening looking obliquely outwards and downwards. Avicularia larger and proportionately wider than in *Kinetoskias cyathus*.

Habitat.—Station 122, lat. 9° 5′ to 10′ S., long. 34° 49′ to 53′ W., 32 to 400 fathoms. Station 299, lat. 33° 31′ S., long. 74° 43′ W., 2160 fathoms; blue mud.

As compared with the second species,—*Kinetoskias arborescens*,—described by Koren and Daniellsen,[1] pretty nearly the same amount of difference exists between that form and *Kinetoskias pocillum*, as between *Kinetoskias smittii* and *Kinetoskias cyathus*. At the same time there are one or two points which induce some hesitation in positively asserting that the second Challenger form and *Kinetoskias arborescens* are not the same. The chief points of difference would appear to be:—1st, The position of the avicularium, which in *Kinetoskias arborescens* is placed at the upper and outer angle, whilst in *Kinetoskias pocillum* it is invariably seated at the middle (or a little below it) of the outer border. 2nd, In *Kinetoskias arborescens* the dorsal surface is strongly striated transversely, the ridges being elevated and oblique from below upwards and inwards, &c., whilst in *Kinetoskias pocillum* the dorsal surface is perfectly even and polished.

With respect to the *Bugula umbella* of Prof. Smitt, as from his admirable description and excellent figures there can, I think, be no doubt that it is the same as *Kinetoskias arborescens*, Koren and Daniellsen, what has been said with regard to a comparison between that form and either of those in the Challenger collection, will equally apply to Prof. Smitt's. His specimen, however, seems to have been imperfect, as it has no peduncle, and appears to be turned inside out, and at all events is represented as it would seem the wrong way up in the figure.[2]

Prof. Smitt's description of the mode of commencement of the zoœcial portion[3] corresponds exactly with what I have been able to make out in *Kinetoskias cyathus*, as does also his admirable account of the mode of formation, and true nature of the web-like expansion connecting the zoœcial branches at the bottom of the cup.

[1] *Loc. cit.*, pl. xii. figs. 9–14, and *Förhandl. Vidensk. Selsk.*, Christiania, 1867, p. 27.

[2] *Loc. cit.*, pl. xix. fig. 30.

[3] *Ibid.*, fig. 31.

4. *Ichthyaria*, n. gen.

Character.—Zoarium continuous, branched; branches irregularly dichotomous or forked, biserial, zoœcia facing in one direction; the two series very loosely connected. Zoœcia ventricose rounded, front entirely calcified.

Ichthyaria oculata, n. sp. (Pl. XIII. fig. 7).

Character.—Zoœcia pyriform or pisciform, square at the top, gibbous on the inner side. Surface smooth and polished; on the back an elongated vertical fissure remains membranous. Orifice semicircular, with a nearly straight entire lower lip. A conical process on the upper and outer angle, perforated at the base—a large round pore on the outer side, close below the angle of the mouth, and two on the inner, one above the other.

Habitat.—Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand. Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

Family VII. Gemellariadæ.

Gemellariadæ (pars), Bk., Voy. of Rattles., vol. i. p. 383, Brit. Mus. Cat., vol. i. p. 33.
Eucratiidæ, Hincks (pars).

Character.—Zoarium submembranaceous, flexible, continuous. Zoœcia opposite, in pairs, unarmed.

With the exception of *Notamia*, the Family as here proposed would include those genera arranged under it in the Brit. Mus. Cat., viz:—

Gemellaria, Savigny.
Didymia, Busk.
Dimetopia, Busk.

To which might perhaps be added:—

Scruparia (pars), Hincks (*nec* Smitt).
Brettia, Dyster.
Huxleya, Dyster.

The Family here contains only the following genera:—

1. *Didymia*, Busk.
   Didymia simplex, Busk.

2. *Dimetopia*, Busk.
   Dimetopia cornuta, Busk.

1. *Didymia*, Busk.

Didymia, Bk., Voy. of Rattles., Brit. Mus. Cat.; Macgilliv., Nat. Hist. Vict., Dec. v. p. 34.

Character.—Zoœcia joined side by side, all facing the same way. At a bifurcation each zoœcium of the primary pair giving off a secondary pair. Frontal area almost entirely membranous. Oœcia on a third intermediate zoœcium at a bifurcation.

Although the zoœcia in *Didymia* are in close apposition, I am unable to perceive that there are any interzoœcial pores between them. The polypide has twelve to fourteen tentacles, and its mouth opens at once into a dilated cavity, without any apparent pharyngeal or œsophageal passage. There is nothing in the form of a so-called funiculus besides the bundle of retractor muscular fibres.

Didymia simplex, Busk.

Didymia simplex, Bk., Brit. Mus. Cat., vol. i. p. 35, pl. xxxix.; Macgilliv., *loc. cit.*, p. 34, pl. xlvi. fig. 6. Wyv. Thoms., Nat. Hist. Rev., vol. v. p. 145.

The only species.

Habitat.—Station 163A, lat. 36° 59′ S., long. 150° 20′ E, off Twofold Bay, 150 fathoms, green mud.

[Bass Strait, 45 fathoms, Voy. of Rattles.; Queenscliff, Portland, Victoria, Maplestone; New Zealand, Hutton.]

2. *Dimetopia*, Busk.

Dimetopia, Bk., Brit. Mus. Cat., vol. i. p. 35; Voy. of Rattles., vol. i. p. 384; Macgilliv., Nat. Hist. Vict., Dec. v. p. 34.

Character.—Zoœcia in pairs, apposed back to back; infundibuliform, with a large orifice; each pair facing in a direction at right angles to that of the next; at a bifurcation each of the separate zoœcia gives off a secondary pair.

Dimetopia cornuta, Busk.

Dimetopia cornuta, Bk., Brit. Mus. Cat., vol. i. p. 35, pl. xxix. figs. 2, 3; Voy. of Rattles.; p. 384, pl. i. figs. 7, 8; Macgilliv., Nat. Hist. Vict., Dec. v. p. 34, pl. xlvi. fig. 5. Wyv. Thoms., *loc. cit.*, p. 146.

Character.—Zoœcia contracted below the middle, orifice oblique, wide above; a strong conical process on each side above, and one or two long projecting spines in front; inserted below the margin.

Habitat.—Station 163A, lat. 36° 59′ S., long. 150° 20′ E., off Twofold Bay, 150 fathoms, green mud (only a small fragment).

[Bass Strait, 45 fathoms, Voy. of Rattles; Queenscliff, Sealer's Cove, Baron v. Müller; Portland, Maplestone.]

Family VIII. Farciminariadæ.

Farciminariadæ, Bk., Brit. Mus. Cat., vol. i. p. 32; (*nec*) Quart. Journ. Micr. Sci., N. S., vol. i. p. 155.

Character.—Zoarium submembranaceous or corneous, continuous, erect, ramose, radicate. Zoœcia quadri- or multiserial, disposed round an imaginary axis, and forming cylindrical or prismatic branches.

1. *Farciminaria*, Busk.

(1) *Farciminaria atlantica*, n. sp. (Pl. XXXI. fig. 6).
(2) *Farciminaria cribraria*, n. sp. (Pl. V. fig. 2).
(3) *Farciminaria magna*, n. sp. (Pl. V. fig. 1).
(4) *Farciminaria brasiliensis*, n. sp. (Pl. XXXI. fig. 2).
(5) *Farciminaria pacifica*, n. sp. (Pl. XXXI. fig. 4).
(6) *Farciminaria gracilis*, n. sp. (Pl. V. fig. 3).
(7) *Farciminaria delicatissima*, n. sp. (Pl. XXXI. fig. 5).
(8) *Farciminaria hexagona*, n. sp. (Pl. XIV. fig. 10, and Pl. XXXI. fig. 3).

1. *Farciminaria*, Busk.

Farciminaria, Bk., Brit. Mus. Cat., vol. i. p. 32; (*nec*) Quart. Journ. Micr. Sci., N. S., vol. i. p. 155; Kirchenpauer (pars)?

Character.—Zoarium furcate or dichotomous; the angle at each bifurcation occupied by a hollow membranous expansion (modified zoœcium?). Zoœcia oblong, elongated, almost entirely membranous in front, which is depressed or flat, with an acute angular border. Avicularia, when present, sessile or subimmersed, placed at the bottom in front. Mouth close to the summit, more or less protruded, the oral valve projecting. Oœcia cucullate, superior.

In the Quart. Journ. Micr. Sci. (*loc. cit.*) I described two forms of a corneous texture, and formed of cylindrical branches constituted of utricular zoœcia, under the generic term *Farciminaria*, following in this, M. Kirchenpauer, to whom I was indebted for the specimens. But I am now satisfied that these two forms cannot be placed in the same genus with my *Farciminaria aculeata*, though belonging, as it seems to me, to the same family. I would therefore venture to propose that the two species in question should, in accordance with my former suggestion, be named *Verrucularia*, v. Suhr, notwithstanding the circumstance that v. Suhr regarded *Verrucularia dichotoma* as a fucus; as which also I believe Dr. Harvey considered *Farciminaria binderi* of Kirchenpauer.

The genus may be regarded emphatically as abyssal; the mean depth at which the species here enumerated occurred, being not less than 1500 to 1600 fathoms, or from 450 to 2750 fathoms.

(1) *Farciminaria atlantica*, n. sp. (Pl. XXXI. fig. 6).

Character.—Zoarium 2 to 3 inches high, arising in a single slender stem from a dense tuft of radical fibres, and dividing into several furcate branches. Zoœcia multiserial, elongate oblong, rounded at the top and slightly prominent; contracted downwards; the sides of the front beset with numerous, simple, incurved, equidistant aculeate spines. A rather large immersed avicularium of an oval form with a semicircular mandible pointing upwards, at the bottom of the front in the middle. Oœcium immersed, surface smooth (not aculeate).

Habitat.—Station 23, off Sombrero Island, 450 fathoms, Pteropod ooze. Station 24, off Culebra Island, 390 fathoms, Pteropod ooze.

Differs from the Australian *Farciminaria aculeata*, Bk., which it otherwise strongly resembles, in the aculeate marginal spines being simple and not furcate, as they mostly are in that species; in the smoothness and comparatively smaller size of the oœcium; and in the presence on very many of the zoœcia of a large avicularium.

(2) *Farciminaria cribraria*, n. sp. (Pl. V. fig. 2).

Character.—Zoarium 3 to 4 inches high. Zoœcia about 0″·05 long; wall reticulate or cribriform. A sessile prominent avicularium at the base of each in front, cup-shaped, with a pointed beak and acute, curved, triangular mandible. Oœcium flattened in front.

Habitat.—Station 323, lat. 35° 39′ S., long. 50° 47′ W., 1900 fathoms, blue mud.

The very peculiar reticulated structure of the walls is a remarkable characteristic of this species.

(3) *Farciminaria magna*, n. sp. (Pl. V. fig. 1).

Character.—Zoarium 5 to 6 inches high; branches very long and straggling. Zoœcia from 0″·055 to 0″·07 long by 0″·015 wide. Walls thin, angles quite sharp, upper border level with the surface. Oœcia large, somewhat flattened, partially immersed, with a vertical depression in the centre of the front; surface slightly wrinkled; with or without avicularia.

Habitat.—Station 153, lat. 65° 42′ S., long. 79° 49′ E., 1675 fathoms, blue mud. Station 325, lat. 36° 44′ S., long 46° 16′ W., 2650 fathoms; blue mud.

In all the specimens from Station 153, there is a minute parasitic Cirriped (?) in the axil of the last bifurcation but one of every branch; apparently a commensal.

Var. *a. armata* (Pl. XXXI. fig. 1).

Character.—Zoarium 4 or 5 inches high, branches long, straggling, once or twice furcate. Zoœcia precisely like those of *Farciminaria magna*, except that, more especially towards the lower part of the branches, they are furnished with an egg-shaped avicularium in the centre at the base and deeply immersed; the opening is quite at the summit, and the mandible appears to form a mere lid, and is rather less than a semicircle.

Habitat.—Station 323, lat. 35° 39′ S., long. 50° 47′ W., 1900 fathoms, blue mud.

(4) *Farciminaria brasiliensis*, n. sp. (Pl. XXXI. fig. 2).

Character.—Zoarium about 2 inches high, with five or six once furcate branches. Zoœcia about 0″·05 × ·0075; frontal area slightly closed in at the bottom; a small, deeply immersed, globular, sessile avicularium, with a semicircular mandible. Oœcia somewhat flattened, not hollowed in front, surface coarsely rugose.

Habitat.—Station 122, lat. 9° 5′ to 10′ S., long. 34° 49′ to 53′ W., 32 to 400 fathoms; red mud.

(5) *Farciminaria pacifica*, n. sp. (Pl. XXXI. fig. 4).

Character.—Zoarium probably large. Zoœcia 0″·06 × ·01; angles thick and rounded, upper border immersed, orifice very slightly prominent. A globose cup-shaped avicularium, with a semicircular mandible placed to one side at the base in front. Oœcium large, convex, surface rugose, with a slight central vertical depression in front, flattened or immersed behind, with a sort of projecting collar; a reniform stigma on the summit.

Habitat.—Station, 241, lat. 35° 41′ N., long. 157° 42′ E., 2300 fathoms, red clay.

The reniform mark on the summit of the oœcium appears to represent the suppressed avicularium of the superjacent zoœcium.

The only specimen in the collection is a fragment about 1 inch long, which constituted the sole contents of a small tube, so that no idea can be formed of the general habit; but it would probably be like that of *Farciminaria cribraria* or *Farciminaria brasiliensis.*

(6) *Farciminaria gracilis*, n. sp. (Pl. V. fig. 3).

Character.—Zoarium 1 to 1½ inches high, branches short, slender, curved, once or twice forked. Zoœcia 0″·05 to ·06 long, slightly narrowing downwards; upper border projecting, lip protruding. A globose, cup-shaped avicularium placed rather to one side, with a triangular obtusely pointed mandible, which is directed obliquely downwards and outwards. Oœcium lofty, constricted below, with an arched lower border forming a blunt process on either side.

Habitat.—Station 70, lat. 38° 25′ N., long. 35° 50′ W., 1675 fathoms, Globigerina ooze. Station 122, lat. 9° 5′ S., long. 34° 50′ W., 32 to 400 fathoms, red mud.

The small size and peculiarly curved, divaricate, slender branches, at once serve to distinguish this species.

(7) *Farciminaria delicatissima*, n. sp. (Pl. XXXI. fig. 5).

Character.—Zoarium from 2 to 3 inches high, composed of once or twice forked straight branches. Zoœcia 0″·10 to ·11 long, much attenuated downwards; upper border subeuculiate. Orifice very prominent when open; walls exceedingly delicate and flexible. No avicularia. Oœcium subconical, rounded in front, enveloped above in a prolongation of the epitheca or epidermis; lower border even. A long pouch distinct from the zoœcial cavity in front of each oœcial cell.

Habitat.—Station 13, lat. 21° 38′ N., long. 44° 39′ W., 1900 fathoms, Globigerina ooze. Station 68, lat. 38° 3′ N., long. 39° 19′ W., 2175 fathoms, Globigerina ooze. Station 64, lat. 35° 35′ N., long. 50° 27′ W., red clay. Station 89, lat. 22° 18′ N., long. 22° 2′ W., 2400 fathoms, Globigerina ooze. Station 106, lat. 1° 47′ N., long. 24° 26′ W., 1850 fathoms, Globigerina ooze. Station 14, lat. 21° 1′ N., long. 46° 29′ W., 1950 fathoms, Globigerina ooze.

(8) *Farciminaria hexagona*, n. sp. (Pl. XIV. fig. 10, and Pl. XXXI fig. 3).

Character.—Zoarium 7 to 8 inches high, composed of very long, straggling, straight, or slightly curved branches, twice furcate; sometimes with a broad web uniting the branches at the bottom of a bifurcation. Zoœcia in six series; 0″·04 to ·05 long., narrow; walls very thin and transparent, angles sharp; upper border quite level. Orifice small, prominent, but with a very narrow chitinous border. Oœcia?

Habitat.—Station 145, lat. 46° 43′ S., long. 38° 4′ E., 140 to 310 fathoms. Station 196, lat. 0° 48 S., long. 126° 58′ E., 825 fathoms, hard ground. Station 195, lat. 4° 21′ S., long. 129° 7′ E., 1425 fathoms, blue mud.

In two out of the six series, the zoœcia are narrower than in the others, and apparently always uninhabited, and without any oral orifice.

Group B. FLUSTRINA.

Family IX. FLUSTRIDÆ.

Flustradæ, Bk., Brit. Mus. Cat., vol. i. p. 46; Gray (pars), Br. Rad., p. 145.
Flustridæ (pars) d'Orb., Rech. s. les Bryoz., Ann. d. Sci. Nat., 1851, p. 314; Hincks, Brit. Mar. Polyz. vol. i. p. 113; Smitt, Krit. Förteck. Skandinav. Hafs-Bryzoer, 1867, p. 357.
Escharidæ (pars), Johnst., Brit. Zooph., 1st ed. p. 248; 2nd ed. p. 263; d'Orb.
Polypiers à réseau (pars), Lamk.
Flustrées, Lamx., Exp. Méth.

Character.—Zoarium membranaceous, expanded and foliaceous, or ligulate; erect (sometimes decurrent on the support), uni- or bi-laminar. Zoœcia quincuncially arranged, more or less open and membranaceous in front, without a raised border; avicularia, when present, usually vicarious.

The Family here contains the following genera:—

§ A. Zoœcia contiguous.

§§ *α. Utrinque porosæ*, Linné.

1. *Flustra*, Linné.
   (1) *Flustra crassa*, n. sp. (Pl. XVI. fig. 6.)
   (2) *Flustra denticulata* Busk (Pl. XXXII. fig. 2).
   (3) *Flustra biseriata*, n. sp. (Pl. XVI. fig. 1).
   (4) *Flustra membraniporides*, n. sp. (Pl. XXXII. fig. 7).

§§ *β. Pagina altera tantum porosæ*, Linné.

2. *Carbasea*, Gray.
   (1) *Carbasea ovoidea*, Busk (Pl. XVI. fig. 3).
   (2) *Carbasea dissimilis*, Busk.
   (3) *Carbasea elegans*, Busk (Pl. XVI. fig. 5).
   (4) *Carbasea pedunculata*, n. sp. (Pl. XVI. fig. 4).
   (5) *Carbasea moseleyi*, n. sp. (Pl. XXXIII. fig. 4).
   (6) *Carbasea pisciformis*, Busk.
   (7) *Carbasea cribriformis*, Busk. (Pl. XXXIV. fig. 8).

§ B. Zoœcia disjunct.

3. *Diachoris*, Busk.
   (1) *Diachoris magellanica*, Busk.
      var. *α distans* (Pl. XVI. fig. 2).

(2) *Diachoris crotali*, Busk.
(3) *Diachoris costata*, Busk (Pl. XXXIV. fig. 4).
(4) *Diachoris inermis*, Busk.
(5) *Diachoris hirtissima*, Heller.

§ A. Zoœcia contiguous.

§§ *a. Utrinque porosæ*, Linné.

1. *Flustra*, Linné.

Flustra, Bk., Brit. Mus. Cat., vol. i. p. 47.
„ (sp.) Linn., Auctt; Hincks, Brit. Mar. Polyz., vol. i. p. 114, § *a*.
Eschara (pars), Pallas.

Character.—Zoœcia disposed in two inseparable layers (except when decurrent).

(1) *Flustra crassa*, n. sp. (Pl. XVI. fig. 6).

Character.—Zoarium broadly lobate, very thick and fleshy. Zoœcia elongated, oblong, entirely membranous in front; a short conical point at each upper angle. Oœcium cucullate, erect.

Habitat.—Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud.

Remarkable for its thick, almost fleshy consistence.

(2) *Flustra denticulata*, Busk (Pl. XXXII. fig. 2).

Flustra denticulata, var. *inermis*, Bk., Brit. Mus. Cat., vol. i. p. 49, pl. xlix. figs. 3, 4.

Character.—Zoarium composed of linear branches slightly expanding at the ends. Zoœcia elongated pyriform, with a few very minute internal hooked spicules on each side, more especially towards the lower part. Avicularia rare, small, obliquely quadrangular, with an acute mandible placed obliquely.

Habitat.—Station 163A, lat. 36° 59′ S., long. 150° 20′ E., off Twofold Bay, 150 fathoms, green mud.

[New Zealand, Dr. Lyall.]

The form denominated *Flustra denticulata* in the Brit. Mus. Cat., p. 49, described and figured, as it would seem, in the most fully developed condition (pl. lvii.), is one which presents considerable difficulty with respect to the varieties it exhibits. In the form shown in pl. lvii. (*loc. cit.*), the border of the front is furnished with very remarkable tooth-like, usually bifid spines, which arch over the front, decussating more or

less in the mesial line; and a small upturned spine is seen on each side of the mouth. In the form termed "*inermis*" (*loc. cit.*, pl. xlix. figs. 3, 4) the curious external marginal teeth are entirely absent. In all other respects, however, it agrees with the former, that is to say, in the peculiar form and position of the avicularia, and the habit and general characters of the zoarium. They agree also in the circumstance that the sides of the zoœcium *within* the frontal membrane are furnished with a few distant, minute, sharp-curved spines or spicules, whose function is very obscure.

The Challenger form agrees in all respects with the second variety, except that it presents no vestige of the ascending spine on each upper angle. But on this account alone it cannot perhaps be looked upon as more than a variety.

The marginal zoœcia are for the most part void of polypides; and they are much more slender than the inhabited ones. But whether inhabited or not, these zoœcia always have their external wall furnished with a series of discoid stigmata, probably homologous with interzoœcial pores or "Rosettenplatten," as they are termed, none of which, however, appear to exist in the ordinary oœcia.

(3) *Flustra biseriata*, n. sp. (Pl. XVI. fig. 1).

Character.—Zoarium composed of very narrow, ligulate, bifurcate branches; probably several inches high. Zoœcia biserial, broadly ovate, truncated below, very convex in front. Orifice very wide.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground. Station 299, lat. 33° 31′ S., long. 74° 43′ W., 2160 fathoms, blue mud.

The ligulate divisions or branches are bordered on each side by a continuous chitinous tube.

(4) *Flustra membraniporides*, n. sp. (Pl. XXXII. fig. 7).

Character.—Zoarium composed of narrow, ligulate, forked lobes. Zoœcia pyriform in outline, with a large oval aperture occupying more than half the length. Border slightly raised. A short marginal spine on each side above; one or two sessile avicularia, with short triangular mandible, on the front of the closed portion of the zoœcia near the bottom. In the marginal zoœcia the avicularium is larger and always single. Oœcium small, inconspicuous, with a flattened, triangular or trifid space in front. Surrounded with a raised fascia, which is continued across the lower border.

Habitat.—Station 163B, Port Jackson, 35 fathoms, hard ground. Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand, shells.

The zoœcia in this doubtfully-placed form are in all respects of the membraniporidan type, but the zoarium is equally that of a *Flustra*.

The trifid space in front of the zoœcium appears to be of the same nature, whatever that may be, as that of the similarly shaped stigma on the oœcium in so many of the Australian Retepores.

§§ *β. Pagina altera tantum porosæ*, Linné.

2. *Carbasea*, Gray.

Carbasea, Gray, Cat. Brit. Rad., 1848.
„ Bk., Brit. Mus. Cat., p. 50.
Semiflustra, d'Orb.

Character.—Zoœcia in a single layer. Front either completely or partially membranous.

(1) *Carbasea ovoidea*, Busk (Pl. XVI. fig. 3).

Carbasea ovoidea, Bk., Brit. Mus. Cat., p. 52, pl. l. figs. 5, 6, 7.

Character.—Zoarium broadly lobate, margin of lobes notched. Zoœcia pyriform, slightly contracted below. Membranous aperture oval, occupying the upper two-thirds of the front, and filled in by a very convex membrane.

Habitat.—Station 149D, Royal Sound, Kerguelen, 28 fathoms. Station 149H, I, K, off Christmas Harbour 127 to 45 fathoms. Station 149G, London River, 110 fathoms. Marion Island, 50 to 75 fathoms. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel. Prince Edward Island, 80 to 150 fathoms. Port William, Falkland Islands, 5 to 10 fathoms. Station 303, lat. 45° 31′ S., long. 78° 9′ W., 1325 fathoms, Globigerina ooze. Station 312, lat. 53° 38′ S., long. 70° 56′ W., 10 to 15 fathoms, mud.

[Strait of Magellan (Moseley); Coast of Patagonia, Darwin; Kerguelen Island, Eaton.]

(2) *Carbasea dissimilis*, Busk.

Carbasea dissimilis, Bk., Brit. Mus. Cat., vol. i. p. 51, pl. xlix. figs. 4–7.
Flustra carbasea, var. *β*, Lamk.

Character.—Zoarium composed of long ligulate branches. Zoœcia pyriform, much attenuated below. Membranous aperture oval. Marginal zoœcia with an acute, short, spinous process at the upper and outer angle. A sessile avicularium below the membranous aperture on each zoœcium.

Habitat.—Station 161, off entrance to Port Philip, 33 fathoms, sand. Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells. Station 163A, off Twofold Bay, 150 fathoms. Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, rock.

[Tasmania, Hooker; Australia, Miss E. Gore.]

(3) *Carbasea elegans*, Busk (Pl. XVI. fig. 5).

Carbasea elegans, Bk., Brit. Mus. Cat., vol. i. p. 53, pl. liv. figs. 6, 7, pl. lvi. fig. 3.

Character.—Zoarium composed of narrow ligulate divisions. Zoœcia oblong. Membranous aperture almost the entire front, square at the lower border.

Habitat.—Station 162, off East Moncœur Island, 38 fathoms, sand and shells. Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand.

[Tasmania, B. M.]

(4) *Carbasea pedunculata*, n. sp. (Pl. XVI. fig. 4).

Character.—Zoarium composed of ligulate branches, all in one plane, dividing dichotomously and of uniform width (about 0·125″). Zoœcia broadly ovate, but irregular in size and shape. Branches bordered on each side by a continuous chitinous tube, and the two tubes are continued into a peduncle about 0″·5 to ·75 long, terminating in a tuft of capillary fibres.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud. Station 76, lat. 38° 11′ N., long. 27° 9′ W., 900 fathoms, Globigerina ooze.

The single specimen of this species included in the collection is unfortunately in a very imperfect condition—torn and ragged—so that the full dimensions of the growth cannot be determined from it. The zoœcia are amongst the largest with which I am acquainted, about 0″·05 × ·035; and the zoarium, like that of most of the very deep water forms, is extremely flaccid and tender.

(5) *Carbasea moseleyi*, n. sp. (Pl. XXXIII. fig. 4).

Character.—Zoarium about 0″·75 high, narrow, fan-shaped, and apparently shortly pedunculate; bordered on each side by a continuous chitinous tube. The growing edge serrated. Zoœcia hexagonal, 0″·04 × ·035, very convex in front, flatter behind; wall very transparent, but entirely calcified. A series of six apparent punctures on each side in the upper half of the front only, the series being continued across the top above the mouth. Besides these, a variable number (8 to 10) of rather smaller punctures towards the upper part of the front. On some of the zoœcia a large horse-shoe-shaped mark is seen in the lower part of the front, apparently representing a cavity in or just within the anterior wall. Orifice large, crescentic, with a very strong chitinous lip.

Habitat.—Station 170, off Kermadec Islands, 520 fathoms, volcanic mud.

This very remarkable and extremely beautiful species is represented by only a single specimen, for which I am indebted to Mr. Moseley, who had mounted it while quite recent

and apparently alive in Canada balsam, having previously stained the tissues with carmine. All the details of its anatomy, consequently, are beautifully displayed. The polypide has about twenty-four tentacles, a rather wide œsophagus, and a simple saccular stomach, without any *diverticulum*, and the rectum opens very low down into the tentacular sheath. The retractor muscles consist of long, slender, non-striated fibres each of which presents a single nucleus at some part of its length (fig. 4*d*). Besides the muscular fibres, there is no appearance of a so-called *funiculus*.

The peculiar horse-shoe-shaped mark visible in a few of the zoœcia appears to represent a flattened cavity on the inner face of the anterior wall, and probably lying between the ectocyst and endocyst, if the calcareous wall be taken to represent the former. In the older zoœcia this cavity is quite empty and clear, but in one or two of the marginal, immature zoœcia, in which the polypide is still represented merely by an elongated mass of granular matter (fig. 4*b*), the faintly seen but distinct horse-shoe-shaped organ appears to contain a collection of extremely minute granules. There is no direct indication whatever that these organs are of an ovarian or testicular character, and in the whole zoarium I have been able to perceive their existence in not more than about six or seven cells.

The lateral and central apparent puncta in the anterior wall have all the characters of the ordinary form of interzoœcial pores or discs ("Rosettenplatten"), and like those structures may be described as perforations in the calcified wall or ectocyst, filled in, however, by a delicate membrane, or rather double membrane, between whose layers are lodged eight to ten minute spherical granules, deeply coloured with the carmine (fig. 4*c*). The outer layer is in this case formed apparently by a very delicate epitheca, and the inner by the equally delicate endocyst.

In several of the zoœcia the polypides appear to have been killed so suddenly that they have not had time to retract themselves wholly into the cell, so that the extremities of the tentacles have been caught by the sudden closure of the operculum.

(6) *Carbasea pisciformis*, Busk.

Carbasea pisciformis, Bk., Brit. Mus. Cat., vol. i. p. 50, pl. lv. figs. 1, 2; pl. lvi. fig. 6; Macgilliv., Nat. Hist. Vict., Dec. v. p. 30, pl. xlv. fig. 6.

Character.—Zoarium broadly lobate, lobes rounded, entire at the margin. Zoœcia elongated, pyriform, truncated at both ends, and much contracted near the bottom, which is again slightly expanded. Oœcia immersed, marked with radiating lines.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand, shells.

[Tasmania, Brit. Mus. Collect.; Queenscliff, Portland, Victoria, Maplestone.]

The polypide has about twenty-four tentacles, and the stomach a long diverticulum. The retractor muscular fibres are very numerous and slender, and neither nucleated nor

striated. In many of the zoœcia, at some distance from the growing edge, but in which the polypide is still quite vigorous, a narrow linear band may be seen on either side within the perigastric cavity, and anterior to the polypide. These bands are formed by a flexuose tube, cæcal at both ends, and having thick walls lined with an hexagonal epithelium. These organs may be probably either ovarian or testicular, but I have failed to perceive anything within them beyond the epithelium. Whatever their nature may really be, they are perhaps homologous with the peculiar horse-shoe-shaped organ in *Carbasea moseleyi*. They are certainly not parasitic vermicules, although, curiously enough, the latter do sometimes occeur in the interior of a zoœcium in this species.

(7) *Carbasea cribriformis*, Busk (Pl. XXXIV. fig. 8).

Carbasea cribriformis, Bk., Brit. Mus. Cat., vol. i. p. 51, pl. lxviii. fig. 1 ; Haswell, Proc. Linn. Soc. N. S. Wales, p. 37.
Retepora cornea, Bk., Voy. of Rattles., vol. i. p. 380.

Character.—Zoarium composed of circular fenestrated fronds, superimposed one upon the other, and growing spirally from a common centre, one from the other. Zoœcia oval, open in front but with a narrow thickened band all round, within the border ; behind they are convex, and faintly wrinkled or striated transversely with faint longitudinal cicatriciform marks extending the length of the zoœcium. Oœcia globose, completely immersed in the superjacent zoœcium. A wide, thin-walled, flexible, radical tube, springs from an aborted zoœcium at the lower angle of each fenestra.

Habitat.—Station 186, Cape York, 8 fathoms, coral mud. Station 188, lat. 9° 59′ S., long. 139° 42′ E., 28 fathoms, green mud. Station 190, lat. 8° 56′ S., long. 136° 5′ E., 45 fathoms, green mud.

[Off Cumberland Island, Voy. of Rattles.]

The peculiar fenestrate zoarium of this very curious form is at once sufficient for its distinction ; the mere external aspect, except as regards the horny consistence, is exactly that of a Retepore. Whether it should be included among the Flustridæ or should not rather be regarded as a quasi-erect Membraniporidan is extremely doubtful. The zoœcia have a membraniporidan character. The way in which the superimposed fronds or lobes spring in a sort of spiral manner from the centre, sometimes to the number of six or more, is very remarkable ; but besides this central or initial attachment, the fronds are also loosely interconnected by the wide radical tubes springing from the lower angle of each fenestra. A condition which is also more or less membraniporidan.

Mr. Haswell (*loc. cit.*) well describes the very peculiar mode of growth in this species.

§ B. Zoœcia disjunct.

3. *Diachoris* Busk.

Diachoris, Bk., Voy. of Rattles., vol. i. p. 382; Brit. Mus. Cat., vol. i. p. 53; Heller; Macgilliv.; Hutton; &c.
Mollia (pars), Smitt.
Eschara (pars), Moll.

Character.—Zoarium flexuose, spreading, loosely adnate, or suberect and free. Zoœcia flustrine, completely disjunct, each connected with six or more by tubular processes.

(1) *Diachoris magellanica*, Busk.

Diachoris magellanica, Bk., Brit. Mus. Cat., vol. i. p. 54, pl. lxvii.; Macgilliv., *loc. cit.*, p. 32, pl. xlvi fig. 2; Hutton.
Diachoris buskei, Heller, Adriat., p. 93.

Character.—Zoœcia suberect, quite open in front. Orifice circular, with a thickened annular peristome. A pedunculate, articulated, capitate avicularium seated on the margin of the aperture near the top on each side.

Habitat.—Port Jackson, 2 to 10 fathoms. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel.

[Portland, Victoria, Maplestone; New Zealand, Hutton; Lyall; Strait of Magellan, Darwin; Adriatic, Heller; Kerguelen, Eaton.]

Var. *a distans* (Pl. XVI. fig. 2).

Zoœcia widely distant.

Habitat.—Station 151, Heard Island, 75 fathoms, volcanic mud (only a small fragment).[1]

(2) *Diachoris crotali*, Busk.

Diachoris crotali, Bk., Brit. Mus. Cat., vol. i. p. 54, pl. lxvi. figs. 1, 2; Voy. of Rattles., vol. i. p. 382, pl. i. figs. 10–12; Macgilliv., Nat. Hist. Vict., Dec. v. p. 32.

Character.—Zoœcia suberect, entirely open in front, with straight sides; three or four punctures on each side and behind; a conical avicularium with a very broad semicircular mandible articulated at each upper angle. Oœcium small, conical above the upper border.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand, shells.

[Portland? Victoria, Macgillivray; Bass Strait, Voy. of Rattles.]

[1] Mr. Hincks (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. viii. p. 73, pl. v. figs. 4, 5, 1881), describes a species of *Diachoris* under the name of *Diachoris distans*, from South Africa, which, however, appears to be quite distinct from the above.

The zoarium, though spreading in a lobate manner over other foliaceous Polyzoa, does not appear to have any real attachment to them. In the description given in Brit. Mus. Cat. it is stated that there is no movable mandible in the curiously formed oral appendages, but in reality these organs consist of a hollow conical membranous bag, whose base looks forwards and downwards, and is closed by a semicircular membranous lid, which clearly represents the mandible of an avicularium. When collapsed, these appendages assume the figure represented in Brit. Mus. Cat.

(3) *Diachoris costata*, Busk (Pl. XXXIV. fig. 4).

Diachoris costata, Bk., Kerguelen Island Polyz., p. 3, pl. x. figs. 5, 6.

Character.—Zoarium very loosely attached, and spreading irregularly. Zoœcia decumbent in straight rows radiating from central points; elongate fusiform, front entirely covered with numerous ribs, sometimes forked at the end, and interdigitating in the mesial line. Orifice semicircular, lower lip straight, entire; four unarticulated oral spines, two above and one on each side. An articulated, capitate avicularium on one side a short distance from the top; the beak much curved and projecting beyond the acute crooked mandible.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel.

[Queenscliff, Victoria, Wilson; Royal Sound, Kerguelen, Eaton.]

(4) *Diachoris inermis*, Busk.

Diachoris inermis, Bk., Brit. Mus. Cat., vol. i. p. 54, pl. lxxii.; Hutton.

Character.—Zoœcia decumbent, boat-shaped, entirely open in front. Two short marginal spines on each side above and a variable number of small incurved spicules on each side of the orifice. No avicularia.

Habitat—Station 149D, Royal Sound, Kerguelen, 20 to 60 fathoms.

[New Zealand, Dr. Lyall; Strait of Magellan, Darwin.]

In the Brit. Mus. Cat. no mention is made of the fine lateral spicules, but as in all other respects the form there intended is identical with the present, this difference cannot be regarded as of any consequence.

(5) *Diachoris hirtissima*, Heller

Diachoris hirtissima, Heller, Adriat., p. 94, pl. i. figs. 6, 7.
Chaunosia hirtissima, Bk., Quart. Journ. Micr. Sci., vol. vii. pl. xxxvi. figs. 12–16.

Character.—Zoœcia elongated oval; suberect, very convex behind. Orifice semicircular, with a thin prominent peristome above. The entire surface and borders in front and behind beset with longer or shorter pointed spines. Avicularia 0.

Habitat.—Station 352A, off St. Vincent, Cape Verde Islands, 10 fathoms.

[Adriatic, Heller.]

Family X. MEMBRANIPORIDÆ.

Celleporidæ (pars), Johnst.
Membraniporidæ (pars), Brit. Mus. Cat., Smitt, Hincks, &c.
Flustrellidæ, *Flustrinidæ*, *Electrinidæ*, *Escharidæ*, &c. (pars), d'Orb.
Biflustridæ (sp.), Bk., Smitt.
Flustradæ (pars), Gray.
Flustra (pars), Linn.
Microporidæ (sp.), Smitt, Hincks.

Character.—Zoarium membranous, membranaceo-calcareous or calcareous, encrusting and adnate, or erect and free, foliaceous or lobed then bilaminar or polygono-cylindrical. Zoœcia depressed in front with a raised border, the area filled in by a chitinous membrane, beneath which may be an entire or partial, calcified lamina.

The numerous and heterogeneous forms which might be arranged more or less artificially under the above definition may be conveniently, and to some extent perhaps naturally, subdivided into five principal types, which may be regarded, at any rate provisionally, as generic, four of which only, however, are represented in the Challenger collection. The fifth, for which I should propose to adopt M. d'Orbigny's[1] appellation *Pyripora*, would include the forms represented by *Hippothoa* (*Membranipora*) *catenularia* of authors.

The following genera are contained in the Challenger collection :—

1. *Membranipora*, Blainville.

§ *a. simplices* (no marginal spines).

(1) *Membranipora albida*, Hincks (Pl. XV. fig. 4).

(2) *Membranipora crassimarginata* (Hincks).

Var. *a. erecta* (Pl. XIV. fig. 3).

Var. *b. incrustans* (Pl. XV. fig. 5).

[1] Palæont. Franç., p. 538.

§ β. *spinosæ.*

(3) *Membranipora spinosa*, d'Orbigny.

(4) *Membranipora galeata*, Busk.

2. *Amphiblestrum*, Gray.

(1) *Amphiblestrum imbricatum*, n. sp. (Pl. XV. fig. 3).

(2) *Amphiblestrum cristatum*, n. sp. (Pl. XV. fig. 1).

(3) *Amphiblestrum papillatum*, n. sp. (Pl. XXXIII. fig. 1).

(4) *Amphiblestrum cervicorne*, Busk.

(5) *Amphiblestrum umbonatum*, Busk.

(6) *Amphiblestrum capense*, n. sp. (Pl. XXIII. fig. 3).

3. *Biflustra*, d'Orbigny.

Biflustra savartii (Audouin) (Pl. XIV. fig. 2).

4. *Foveolaria*, n. gen.

(1) *Foveolaria elliptica*, n. sp. (Pl. XXIII. fig. 5).

(2) *Foveolaria orbicularis*, n. sp (Pl. XXIII. fig. 4).

(3) *Foveolaria tubigera*, n. sp. (Pl. XIV. fig. 4).

(4) *Foveolaria falcifera*, n. sp. (Pl. XV. fig. 6).

1. *Membranipora*, Blainville.

Membranipora (pars), Blainv., Johnst., Auctt.
Eschara (pars), Pallas.
Flustra (pars), Linn., Lamk., Lamx., &c.
Discopora (pars), Lamk.
Annulipora, *Conopeum*, *Cellepora*, *Amphiblestrum* (sp.), Gray.
Cellipora (pars), d'Orb., Hag., &c.
Marginaria, Roemer.

Character.—Zoarium encrusting, adnate, calcareous or subcalcareous; zoœcia quincuncially or serially disposed in transverse rows or irregularly; no internal calcareous lamina. Operculum incomplete.[1]

The genus *Membranipora*, even as here restricted, includes so many species that it becomes advisable to subdivide it into sections. I am acquainted, either actually or by published descriptions, with between thirty and forty living species, to which no doubt copious additions remain to be made. I have thought it would be convenient, therefore, to arrange them in two sections with nearly equal numbers in each, and distinguished respectively by the artificial character of having or not having marginal spines.

[1] The term *incomplete* is applied to an operculum whose lower border is membranous and more or less ill defined.

§ *a. simplices.*

(1) *Membranipora albida* (?), Hincks (Pl. XV. fig. 4).

(?) *Membranipora albida*, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. vi. p. 81, pl. x. fig. 5, 1880.

Character.—Zoarium very delicate, lace-like, closely adnate (on a *Cellepora*). Front oval, border thin, beaded or subcrenate. Avicularia adventitious, placed at the bottom of the front of a zoœcium, oblique, with a much raised beak. Oœcia small, cucullate, surface finely granular.

Habitat.—Station 172, Off Nukalofa, Tongatabu, 18 to 20 fathoms, coral mud. Station 75, lat. 38° 37′ N., long. 28° 30′ W., 450 fathoms, volcanic mud.

[Singapore, on *Tubipora musica*, Hincks.]

The very close resemblance of this form to that described by Mr. Hincks leaves little room for doubt as to their identity; the chief point of difference appears to be the larger size of the avicularia in Mr. Hincks' form.

(2) *Membranipora crassimarginata*, Hincks (sp.).

Var. *a. erecta* (Pl. XIV. fig. 3).

Character.—Zoarium foliaceous, expanded. Zoœcia quincuncial or irregularly serial, contiguous or discrete. Front regularly oval, entirely membranous. Margin rounded, granular. Avicularia vicarious; smaller than the zoœcia, with a large broadly spatulate mandible pointing directly upwards. Oœcia?

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 to 85 fathoms, sand, shells. Station 151, Off Heard Island, 75 fathoms, volcanic mud.

Var. *b. incrustans* (Pl. XV. fig. 5).

Membranipora crassimarginata, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. vi. p. 71, pl. ix. fig. 1.

(?) *Biflustra lacroixii*, Smitt, Florid. Bryoz., pt. ii. p. 18, pl. iv. figs. 85–88.

Character.—Zoarium adnate (upon shell). Avicularia usually of equal size with the zoœcia. Border sometimes thicker.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha, 110 to 150 fathoms.

[Madeira—J. Y. J. *teste*, Hincks; Gulf of Florida—Pourtalès, 13 to 60 fathoms.]

The only difference between the form here described and that noticed by Mr. Hincks in Mr. J. Y. Johnson's collection from Madeira, consists in the apparently more robust or coarser structure of the latter. In the Challenger specimens (very few, however, in

number) the border can in none be said to be crenate, nor is it specially entitled to be called "thick," seeing that it is by no means thicker than in many other allied forms. In the figures here given, however, it should be remarked that the border is not shown quite as thick as it sometimes is. In Prof. Smitt's figures it is also shown as very thin.

§ β. *spinosæ.*

(3) *Membranipora spinosa*, d'Orbigny.

Membranipora spinosa, d'Orbigny, Voy. en Amér. Mérid., pl. viii. fig. 1.
„ *ciliata*, Macgilliv., Nat. Hist. Vict. Dec. iii. p. 30, pl. xxv. fig. 3.

Character.—Zoarium encrusting; zoœcial areas distant, very regularly oval; eight incumbent marginal spines.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

[South Patagonia, d'Orbigny; Australia, Macgillivray.]

(4) *Membranipora galeata*, Busk.

Membranipora galeata, Bk., Brit. Mus. Cat., vol. i. p. 62, pl. lxv. fig. 5.

Character.—Orifice oval; margin thin, membranaceous. Two straight, articulated, tapering, hollow spines, open at the point on each side above. Oœcium cucullate, grooved above the border in front, and crowned with an avicularium with an elongate, spear-shaped mandible pointing directly forwards. A long pedunculate, trumpet-shaped, avicularium rises from the front below the aperture.

Habitat.—Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud.

The peculiar elongated avicularium on the summit of the oœcium is sometimes replaced by one of the trumpet form; in either case this avicularium properly belongs to the superior zoœcium.

Var. *a. furcata.*

The lower pair of spines furcate and the anterior avicularium often wanting, sometimes sessile and of large size, with a small horn on either side.

Habitat.—Off Marion Island, 50 to 75 fathoms. Station 150, lat. 52° 4′ S., long. 71° 22′ E., 150 fathoms, coarse gravel. (On *Onchopora sinclairii*, *Salicornaria*, sp.)

Var. *b. multifida.*

Lower pair of marginal spines multifid.

Habitat.—Simon's Bay, Cape of Good Hope. Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud. (On the test of an Ascidian.)

Var. *c. erecta.*

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand. (On a species of *Salicornaria.*)

2. *Amphiblestrum*, Gray.

Membranipora (pars), Auctt. (type, *Membranipora flemingii*).

Character.—A partial internal calcareous lamina. Aperture often more or less trifoliate, or obovate.

(1) *Amphiblestrum imbricatum*, n. sp. (Pl. XV. fig. 3).

Character.—Zoarium incrusting, very closely adnate (on an *Eschara*). Zoœcia, outline arched above, contracted inferiorly. Border thick and tumid, so that the area is very small and almost entirely occupied by a very thick lamina, from the lower part of which springs a strong, calcareous, hatchet-shaped process, on one edge of which is an avicularium, with a slender acute mandible pointing upwards. Oœcia inapparent.

Habitat.—Simon's Bay, Cape of Good Hope.

The zoœcia are disposed very regularly in quincuncial order, and imbricated like fishes' scales or rounded tiles. But the great peculiarity is the curious avicularian process in front of the zoœcia, which is thus almost wholly concealed. *N.B.*—In the figure the border of the front is shown much too thin.

(2) *Amphiblestrum cristatum*, n. sp. (Pl. XV. fig. 1).

Character.—Zoarium of a dark brown colour, thick. Zoœcia in the older portions quite immersed. Area pyriform, much expanded above and contracted below. Margin much raised, acute, smooth. Orifice suborbicular, occupying the upper half of the area; lamina obscurely granular. Two very stout articulated spines close together on each side above. On the sterile zoœcia a small, usually aborted avicularium at the summit. Oœcia large, galeriform, with a strongly marked visor-like crescentic space in front, and at the summit a large avicularium, sometimes sessile, sometimes elevated on a long trumpet-shaped peduncle; mandible obtusely lanceolate, pointing directly forwards. Occasionally a long trumpet-shaped pedunculate avicularium springs from the front of the zoœcium below the aperture.

Habitat.—Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud.

This is one of the most remarkable forms among the Challenger Membraniporidæ. The resemblance of the zoœcium, with its crest and visor-like conformation in front to a

crested helmet is very striking. In the fertile zoœcia both the marginal spines or their basal joints persist in front of the oœcium.

(3) *Amphiblestrum papillatum*, n. sp. (Pl. XXXIII. fig. 1).

Character.—Zoarium very delicate and thin, closely adherent to shell. Zoœcia more or less disjunct, leaving angular spaces. Area in the younger zoœcia oval, in the older irregularly pyriform. Orifice ovate, occupying about half the area. Surface of lamina finely granular. Small avicularia having a triangular mandible on small papillary eminences seated in the angular interzoœcial spaces.

Habitat.—Station 208, lat. 11° 37′ N., long. 123° 31′ E., 18 fathoms, blue mud.

(4) *Amphiblestrum cervicorne*, Busk.

Membranipora cervicornis, Bk., Brit. Mus. Cat., vol. i. p. 60, pl. c. fig. 3, Macgilliv., Nat. Hist. Vict., Dec. iii. p. 32, pl. xxv. fig. 8.

Character.—Frontal area oblong or oval; a strong, much projecting process arising at each upper angle, branching like a stag's horn and bending over the front, usually meeting and sometimes inosculating; several other simple or forked, marginal spines. Oœcia galeriform, crowned with a small avicularium.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

[Williamstown, Victoria, Macgillivray.]

(5) *Amphiblestrum umbonatum*, Busk.

Membranipora umbonata, Bk., Brit. Mus. Cat., p. 57, pl. lxxiii. figs. 6, 7; Macgilliv., Nat. Hist. Vict., Dec. iii. p. 31, pl. xxv. fig. 6.

Character.—Area broadly elliptical; border low; a jointed spine on each side of the mouth. A projecting rostriform avicularium on the front below the aperture. Oœcia globose, prominent, surface brilliant, with a triangular mark in front.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud (on *Fucus*). Station 313, lat. 52° 20′ S., long. 67° 39′ W., 55 fathoms, sand.

[Tasmania, Mrs. Smith; Australia, Macgillivray.]

The oœcium, as it rises in front of the superjacent cell, raises with itself the avicularium, with which, consequently, it then appears to be surmounted.

(6) *Amphiblestrum capense*, n. sp. (Pl. XXIII. fig. 3).

Character.—Zoarium erect, composed of short, usually furcate, spreading, cylindrical, or subcompressed branches. Zoœcia disposed more or less quincuncially, or in subalternate longitudinal rows on all sides. Frontal areas as wide as long, arched above, slightly contracted below. Border very thick, continuous with the partial lamina below. Aperture obovate or circular, entirely occupied by the operculum, which is obovate, with the occlusor muscles attached about the middle on each side (fig. 1).

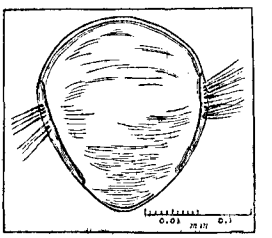


FIG. 1.—*Amphiblestrum capense.*

Habitat.—Simon's Bay, Cape of Good Hope.

A small upward spine is articulated on each side above, beyond the border (often wanting or readily detached). The species is very doubtfully placed with *Amphiblestrum*.

3. *Biflustra*, d'Orbigny.

Biflustra, d'Orb., Rech. sur. les Moll. Bryoz. Ann. d. Sci. Nat., sér. 3, t. xviii. p. 330; Palæont. Franç., p. 241; Bk., Crag Polyz., p. 71; Manzoni, Stoliczka, Macgilliv. (sp.), Smitt (pars).
Flustrellaria (pars), d'Orb.

Character.—Zoarium dimorphous, encrusting or decurrent and unilaminar, or foliaceous, erect and bilaminar, readily fissile in all directions. Zoœcia in alternate series, longitudinal or transverse.[1] Zoœcia flustrine, quadrangular or hexagonal (?), with a denticulate lamina at bottom.

Biflustra savartii, Audouin (sp.) (Pl. XIV. fig. 2).

Flustra savartii, Audouin, Egypte, pl. x. fig. 10.
Membranipora savartii, d'Orb., Palæont. Franç., p. 542; Bk., Crag Polyz., p. 31, pl. ii. fig. 6.
„ *corrugata*, Blainv., Dict. d. Sci. Nat., vol. lx. p. 412.
Biflustra savartii, Smitt, Florid. Bryoz., part ii. p. 20, pl. iv. figs. 92–95.

Character.—Zoarium dimorphous, at first decurrent, afterwards rising into a bilaminar expansion. Zoœcial area arched above, with straight sides, and slightly contracted below. Border thick, granular. Aperture oval, lamina finely granular.

Habitat.—Samboangan, Philippine Islands, 10 fathoms.

There may be some doubt whether this is really the *Flustra savartii* of Savigny and of the Crag, but it is very like it, and almost certainly identical with Prof. Smitt's species.

With respect to the true limits of *Biflustra*, regarded as a generic group distinct from Membranipora, opinions may very fairly differ widely.

[1] As in *Biflustra clathrata*, Reuss, which may, however, belong to *Melicerita*.

4. *Foveolaria*, n. gen.

Character.—Zoarium erect, branched and cylindrical, or foliaceous and bilaminar. Front of zoœcia with a thick granular border very deeply imbedded in a pit formed by the thickening of the general ectocyst. A sessile avicularium immediately below or in front of the lower border of the pit.

(1) *Foveolaria elliptica*, n. sp. (Pl. XXIII. fig. 5).

Character.—Zoarium slender, composed of cylindrical forked branches. Front of zoœcia oval or broadly elliptical, border very wide, oral valve occupying rather more than the upper half of the membranous front. Oœcia large, prominent, subglobose, obscurely punctate. Avicularium horizontal, the mandible pointing obliquely to one side.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells. Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

(2) *Foveolaria orbicularis*, n. sp. (Pl. XXIII. fig. 4).

Character.—Zoarium irregularly branched, branches cylindrical, sometimes inosculating, and very irregular in thickness and direction. Zoœcia short. Front orbicular, border rounded, granular; a partial internal lamina, in which is a central elliptical transverse aperture. Median avicularium of small size, with a triangular mandible pointing in various directions.

Habitat.—Station 147, lat. 46° 16′ S., long. 48° 27′ E., 1600 fathoms, Diatom ooze.

In this species, as in *Myriozoum truncatum*, the openings of the zoœcia remain patent only at the very extremities of the branches; elsewhere they are completely obliterated, the only openings seen on the almost uniformly smooth surface of the branches being those belonging to the avicularia, which would appear to be left functionally efficient long after the obliteration of the zoœcia themselves.

(3) *Foveolaria tubigera*, n. sp. (Pl. XIV. fig. 4).

Character.—Zoarium foliaceous, biflustridan in aspect. Zoœcia completely immersed, entirely membranous in front, with a rather thin granular border, broadly oval, slightly constricted about one-third down. General surface entire, smooth. Median avicularium prominent, with an acute mandible or pointed beak, directed horizontally to one side.

Besides this a small avicularium on each side towards the upper part of the front, with a triangular mandible looking directly upwards. On one side of the opening, about one-third from the top, a short wide trumpet-shaped hollow articulated process, closed with a circular chitinous lid. Oœcia subglobose, prominent, but at the same time deeply immersed.

Habitat.—Simon's Bay, Cape of Good Hope.

The curious trumpet-shaped organ on one side only of the opening may probably be a form of avicularium.

I have found it difficult to decide upon the proper place for this form, though it undoubtedly comes within the membraniporidan type. It is placed with the two preceding and the next species, owing to the deep and early immersion of the front of the zoœcium and the presence of the median marginal avicularium.

(4) *Foveolaria falcifera*, n. sp. (Pl. XV. fig. 6).

Character.—Zoarium adnate. Zoœcia completely immersed, so that the general surface appears perfectly even with the openings of the sharply defined pits, at the bottom of which the real front of the zoœcium is placed. The primary area or front, surrounded with a thin granular border, is seen with great difficulty; it is broadly oval, truncated at the bottom, where there is an immersed avicularium, and it is entirely membranous. The secondary opening is elongated and unequally trifoliate or coarctate, but the constriction is greater on one side than the other, and the whole opening becomes oblique and irregularly hour-glass-shaped, much wider below than above; as the ectocyst becomes thickened to form the secondary orifice, the median avicularium increases in size, eventually equalling in length the entire width of the lower border of the opening, across which it lies horizontally, with a strong curved falciform mandible. Behind, the zoœcia are convex, suboval, or pyriform, with a thin diaphanous wall, upon which is a verrucose projection towards the lower part.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

The avicularium in this case is one of the most extraordinary among the multiform varieties of that organ.

Only a single specimen of the species occurs in the collection, which is adnate upon a *Myriozoum*, and at first sight might be taken for a cylindrical zoarium; and it is not improbable that it is dimorphous, and will be met with perhaps in the biflustran form as well as in the hemescharine. It does not appear to be actually attached to its support though completely sheathing it.

Family XI. MICROPORIDÆ.

Microporidæ (pars), Smitt, Hincks.
Membraniporidæ (pars), Auctt.

Character.—The much depressed front of the zoœcia beneath the chitinous epitheca wholly occupied, except at the summit, by a strong calcareous lamina, usually perforated or fissured on the sides, and sometimes forming a transverse diaphragm, which divides the cavity of the zoœcium into two chambers.

Besides the genera classed in the Family as thus defined, I should place in it *Diplopora*, Macgillivray, and *Setosella*, Hincks.

The Family here contains the following genera :—

1. *Micropora*, Gray.
   (1) *Micropora uncifera*, n. sp. (Pl. XV. fig. 7).
   (2) *Micropora coriacea* (Esper).

2. *Vincularia*, Defrance.
   (1) *Vincularia gothica*, d'Orbigny (Pl. XXIII. fig. 1).
   (2) *Vincularia gothica*, var. *granulata*, nov.
   (3) *Vincularia labiata*, n. sp.

3. *Steganoporella*, Smitt.
   Steganoporella magnilabris (Busk) (Pl. XXIII. fig. 2).

4. *Caleschara*, Macgillivray.
   Caleschara denticulata, var. *tenuis*, nov. (Pl. XXI. fig. 9).

1. *Micropora*, Gray.

Flustra (pars), Johnst., &c.
Discopora (pars), Lamk.
Micropora, Gray.
Membranipora (pars), Brit. Mus. Cat.
Lepralia (sp.), Norman.
Steganoporella (sp.), Hincks.
Reptescharellina (pars), d'Orb.

Character.—Zoarium incrusting. Zoœcia with an internal calcareous lamina occupying the entire area, with a perforation at each upper angle below the orifice, which is apical, with a continuous calcareous peristome.

(1) *Micropora uncifera*, n. sp. (Pl. XV. fig. 7).

Character.—Zoarium closely adnate (on *Eschara* and *Fucus*). Zoœcial area subrhomboidal, broad (0″·02 to ·025). Border thin and sharp. Lamina concave, with a large oval opening on each side above. Surface very finely punctate. Orifice semicircular, with a straight entire lower lip. Peristome thickened all round, but especially above, where it is strongly beaded. A small articulated marginal spine on each side of the summit. On the lower part of the front a very large and prominent avicularium, with an acute, incurved, uncinate mandible, pointing obliquely upwards—a correspondingly curved acute beak. Oœcia large, prominent, with a sinus or notch on each side at the bottom (not shown in the figure), and finely punctate.

Habitat.—Station 135c, off Nightingale Island, 110 to 150 fathoms, and (135a), off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel.

(2) *Micropora coriacea*, Esper (sp.).

Flustra coriacea, Esper.
Discopora coriacea, Lamk., Lamx., Blainv.
Micropora coriacea, Gray, Smitt, Hincks.
Membranipora coriacea, Brit. Mus. Cat.

Character.—Front broadly elliptical; margin terminating on each side of the orifice in a usually small (sometimes large) tubercle. Lamina punctate, occasionally with a perforation on each side close below the orifice. Orifice semicircular, with a straight entire lower lip. Oœcia subimmersed, with an umbonate projection in front.

Habitat.—Station 135a, off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel (on shell). Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms.

[Shetland, Antrim, Cornwall, Guernsey, Hastings, Caithness; Gulf of Florida, 36 to 135 fathoms, Pourtalès.]

2. *Vincularia*, Defrance.

Vincularia, Defrance; d'Orb.; Stoliczka; Brit. Mus. Cat., &c. (all in part) *nec* Smitt; *Cellaria*, *Eschara*, *Membranipora*, *Steganoporella*, &c., &c., Auctt.

Character.—Zoarium erect, continuous, branched or simple; radicate or fixed. Subcylindrical or polygonal. Zoœcia disposed in alternate longitudinal series. Frontal area quadrangular, oblong, arched above, in the natural state filled in by a chitinous epitheca, in which is seated the oral orifice. Beneath the epitheca a calcareous lamina, occupying the lower two-thirds of the area, and terminating above in a free border, from which a median process arises, which, joining above a process from each side of the zoœcium on a level with the lower border of the orifice, forms with those processes a transverse bridge with an arch on each side of the median process. Opercula incomplete

below, composed of a thickish membrane supported on the inner face by a strong chitinous bow having a projecting process near each lower angle for the attachment of the occlusor muscles. Œcia represented by a small chamber in the upper part of the cell, which opens above the oral orifice.

Few questions have given rise to more disputation and confusion than as to what should be understood under the term *Vincularia*. I am not, however, here prepared to enter into this *vexata quæstio*, with respect to which some useful remarks by Mr. Hincks will be found in one of his communications on the Family Microporidæ.[1]

The above definition, therefore, is only proposed provisionally, and it is here intended to restrict the term to cylindrical or rather polygonal, continuous growths, partaking of the characters of *Micropora* and *Steganoporella*, and intermediate, as it were, between those two genera, and forming with them the Family Microporidæ; differing from *Micropora* chiefly in the conformation of the oral orifice and the absence of distinct œcia, and from *Steganoporella* in the cavity of the zoœcium not being divided into two chambers, in the incompleteness of the operculum, and its simpler chitinous framework, the absence of the two suboral chitinous trabeculæ, &c

(1) *Vincularia gothica*, d'Orbigny (Pl. XXIII. fig. 1).

Vincularia gothica, d'Orb., Palæont. Franç., p. 68, pl. deliv. figs. 13–16.
„ *novæ hollandiæ*, Haswell, Proc. Linn. Soc. New South Wales, p. 41, pl. iii. fig. 3.
„ *steganoporoides*,[2] Macgilliv., New Species of Bryozoa from the Marion Islands, Proc. Roy. Soc. Victoria, June 1881, p. 6, pl. ii. fig. 5.

Character.—Zoarium furcately branched, octagonal. Zoœcia elongate, arched above, straightly truncate at bottom; border smooth. Primary or epithecal orifice semicircular or subcrescentic. Lamina occupying the lower two-thirds of the area. Its upper border somewhat incurved. On a level with the upper border of the lamina a tooth-like process springs from each side of the zoœcium, which gradually elongating meet in the mesial line, where they are joined by a median process or denticle, which rises gradually from the upper border of the lamina, thus forming a bridge with two arches and a thick central pier. Surface of bordering ridges and lamina perfectly smooth and imperforate. Œcia and avicularia 0. Operculum 0″·013 × ·0085 incomplete below, membrane thick, supported on the inner face near the border by a very strong chitinous arched bow,

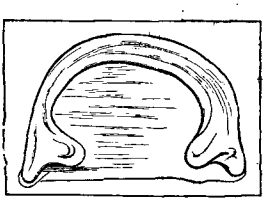


Fig. 2.—*Vincularia gothica.*

[1] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. ix., 1882, p. 119.

[2] Mr. Hincks (Gen. Hist. Mar. Polyz., *Ann. and Mag. Nat. Hist.*, ser. 5, vol. ix. p. 119, 1882) seems to regard this as a form of his *Steganoporella smittii* (Brit. Mar. Polyz., vol. i. p. 178), which, however, I should myself refer to the genus *Micropora*. It is clearly quite distinct from Mr. Macgillivray's species.

having a hooked process projecting at each lower angle for the attachment of the occlusor muscles.

Habitat.—Prince Edward Island, 80–150 fathoms.

[Marion Island.]

(2) *Vincularia gothica*, var. *granulata*.

Slenderer habit; surface of ridges and lamina granular. Operculum more rounded and the chitinous arch not so strong.

Habitat.—Station 151, off Heard Island, 75 fathoms, volcanic mud.

Whether this should be regarded as a variety or raised to the rank of a distinct species may be a matter of doubt. The difference in the character of the surface is very marked, as well as the slenderer habit. As the collection affords numerous specimens, it may, however, be observed that no apparently transitional forms are met with.

(3) *Vincularia labiata*, n. sp.

Character.—Zoarium furcately branched; branches octagonal. Zoœcial area oblong, contracted below or subovate, acutely arched above. A projection immediately below the oral orifice. Lamina imperforate, surface finely granular. The transverse bridge below the internal orifice formed in the same way as in *Vincularia gothica*, except that the central pier, instead of rising from the upper edge of the lamina, commences above from the conjoined lateral process, and gradually descends to become anchylosed to the lamina. This descending process is very rough and irregular in outline. Operculum 0″·013 × ·007 semicircular or subcrescentic, with a very slender chitinous border and an internal chitinous arch seen on the posterior aspect, with a hooked process at each end for the attachment of the occlusor muscles.

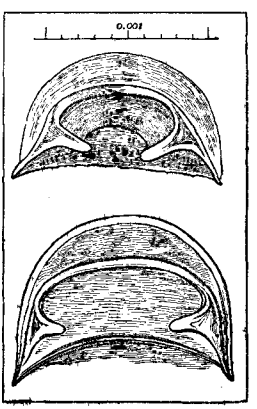


FIG. 3.—*Vincularia labiata*.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

This species may be at once distinguished from the preceding by the strong projection forwards of the oral bridge, which is quite obvious even before the removal of the chitinous epitheca; and it is curious to observe that the median process or pier of the bridge, instead of rising up from the lamina, descends from above and does not begin to be formed before the junction of the lateral arches.[1]

[1] As the last two forms were not at first distinguished from *Vincularia gothica*, no figures of them have been prepared.

3. *Steganoporella*, Smitt.

Steginoporella, Smitt, Florid. Bryoz.
Steganoporella; Hincks, Brit. Mar. Polyz.; Waters; Macgilliv.
Membranipora (pars), Brit. Mus. Cat.; Auctt.
Vincularia (sp.), d'Orb.

Character.—Zoarium polymorphous; erect and branched or lobate; or decumbent, and foliaceous and crustaceous. Zoœcia oblong, arched above. Frontal area occupied by a delicate chitinous membrane, which is closely adnate to the internal calcareous lamina for about the lower half of the area; above free, and supporting the operculum, and having on each side, below the orifice, a minute forked or irregularly branched vertical chitinous rod. Opercula large, semicircular, usually of two kinds, the membranous portion supported by a branching chitinous framework. A strong internal calcareous lamina, which, about the middle of the length of the cell, bends backwards to the posterior wall, forming a transverse diaphragm, by which the cell is divided into two distinct chambers, communicating by a phrenic opening through which the polypide is protruded supported on or passing over a large hollow process rising from the upper and anterior part of the transverse diaphragm.

The very peculiar conformation of the zoœcium in this genus or subgenus is not very easily described. It may be briefly said that the general cavity of the zoœcial cell is divided into two chambers, an upper, probably oœcial in function, in the fertile cells, and an inferior, in which the polypide is lodged. This division into two chambers is effected by the bending backwards of the calcareous lamina, which, instead of ceasing with a free border as in *Vincularia* (*mihi*), is apparently attached all round to the sides and back of the general zoœcial cavity, but leaving posteriorly a rather large opening, through which the polypide is extruded along an imperfectly tubular passage which bends forwards to the orifice, and is supported beneath by a very peculiar hollow process rising from the convex upper surface of the diaphragm.

The space, therefore, of the upper chamber, on each side of the diaphragmatic opening and supporting fulcrum, forms a vaulted cavity occupying the upper half of the entire cell, and no doubt, as has been suggested, serving as an oœcial receptacle. There are no other distinctly oœcial organs. In two out of the three existing species of the genus, limited as above, with which I am myself acquainted, this upper or oœcial compartment is more developed in some of the zoœcia than in others, and the difference is marked by a difference in the size and pattern of the chitinous framework of the operculum. In the third species, a New Zealand form, which I have termed *Steganoporella neo-zelanica*,[1] which does not occur in the Challenger collection, there is, however, no marked difference between the opercula of different cells. Other peculiarities, not at first sight so obvious

[1] *Quart. Journ. Micr. Sci.*, N. S., vol. i. p. 155, pl. xxxiv. fig. 4.

as the above, are:—The existence in the chitinous epithecal membrane, on each side close below the mouth, in all three species known to me, of a very minute chitinous furcate spiculum, as it may be termed, which is lodged within the thickness of the epithecal membrane. These spicula are probably to some extent homologous with the chitinous trabeculæ on each side the orifice in all the Salicornariadæ, and which in that Family serve as supports for the articulation of the elaborate opercula with which all its members are furnished. Another circumstance should also be mentioned, though not as by any means a distinctive character, as it will probably be found of frequent occurrence, viz., the existence of a delicate chitinous hollow filament, which also, as in the Salicornariadæ, follows the contour of the frontal areas, and is apparently continuous throughout the zoarium, serving, it may be imagined, as a channel of communication throughout the entire zoarium, or where the latter is divided into internodes, throughout each separate segment.

Steganoporella magnilabris, Busk (sp.) (Pl. XXIII. fig. 2).

Membranipora magnilabris, Bk., Brit. Mus. Cat., p. 62, pl. lxv. fig. 4.
Steginoporella elegans, Smitt, Florid. Bryoz. (*nec. Eschara elegans*, M. E.).
Steganoporella magnilabris, Hincks; Waters; Macgilliv., Nat. Hist. Vict., Dec. vi. p. 43, pl. lx. fig. 1.
? *Biflustra crassa*, Haswell.
Steganoporella neo-zelanica (sp.), Waters.

Character.—Zoarium polymorphous; erect, foliaceous, expanded or branched, uni- or bi-laminar (escharine form); or subcrustaceous or decumbent (membraniporidan form); or tubular (siphonella-form). Zoœcia oblong, arched above; border thick, rounded, granular, usually a broad tooth-like articular projection on each side about the middle. In the natural state, the frontal area is covered in by a delicate chitinous membrane, the upper half of which is free and contains the external oral orifice and operculum, and towards each side a minute furcate trabecula; the lower half closely adnate to the subjacent calcareous perforated lamina. Opercula suborbicular, of two kinds, one larger (œcial ?), in which the membrane is supported by a chitinous framework, consisting of two convergent rods; and the other smaller (zoœcial), in which the rods are represented by a continuous chitinous bow. In both the margin of the operculum is furnished on the posterior aspect with a row of acute, conical, flexible spicules.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms (ramose or escharine form).

[Abrolhos Islet, Darwin; Algoa Bay, Bowerbank; Port Dalrymple, Voy. of Rattles., (hemescharine form); Gulf of Florida, Pourtalès (escharine- and siphonella-forms), Smitt; ? Miocene fossil, Gipps Land, Waters (escharine form); Tongatabou, Sir E. Home.]

In his account of the Floridan Bryozoa, Professor Smitt gives *Eschara elegans* of

M. Milne-Edwards as a synonym of this species, but in this view I am quite unable to support him, agreeing in that respect with Mr. Waters and Mr. Macgillivray, and I presume also with Mr. Hincks. Mr. Waters,[1] again appears to regard it as synonymous with my *Vincularia* (*Steganoporella*) *neo-zelanica*, from which, however, it is quite dis-

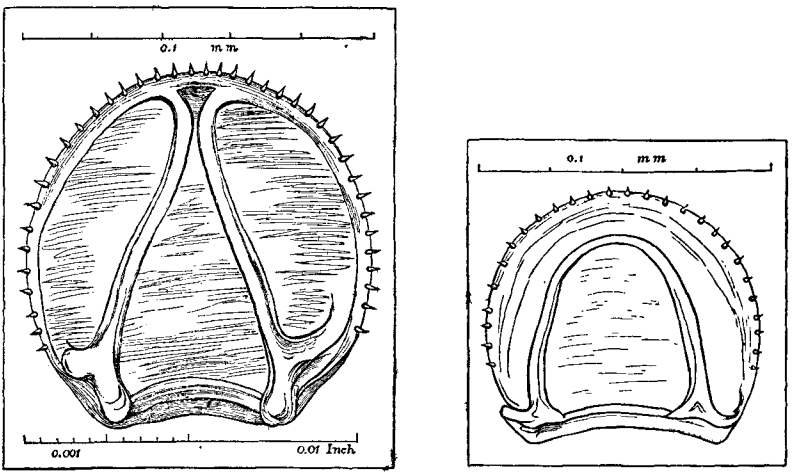


FIG. 4.—*Steganoporella magnilabris.*

tinct, as may be seen in several points of their structure, and very readily in the opercula, which in *Steganoporella neo-zelanica* are all of one kind, and present a totally different pattern in the chitinous framework, &c.[2]

4. *Caleschara*, Macgillivray.

Caleschara, Macgilliv., Nat. Hist. Vic., Dec. v. p. 45.
Membranipora (sp.), Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. vii. p. 152, 1881.

Character.—Zoarium polymorphous; erect, foliaceous and contorted, or composed of ligulate branches and bilaminar; or decurrent and encrusting. Zoœcial area pyriform; the margin very thick and bevelled off to a considerable depth, so as to leave a very contracted elliptical aperture, at first membranous, but eventually occupied in the lower two-thirds by a calcareous lamina attached below to the bottom of the aperture, and above by a broad band to each side, and leaving on either side an elongated fissure. The upper third above the lamina represents the internal or secondary oral orifice. In the

[1] *Geol. Journ.*, Nov. 1882, p. 506, pl. xxii. figs. 7–7*a*.
[2] Several fine specimens of this species, in the hemescharine state, are in the British Museum.

natural state the entire area is filled in by a rather thick epithecal membrane, in which alone is seated the semicircular or subcrescentic operculum. Fertile cells distinguished by their greater width.

This curious type appears to have been first noticed by Mr. Macgillivray, who describes the zoarium in his specimens as "small, foliaceous, and convoluted," and Mr. Hincks as "foliaceous and bilaminar or incrusting." The few fragmentary specimens in the Challenger collection, on the other hand, represent portions of a small zoarium, composed of narrow, compressed ligulate branches, dividing irregularly in a furcate manner. The zoœcial character, however, in the main corresponds so exactly with that given to *Caleschara denticulata* by Mr. Macgillivray and Mr. Hincks, as apparently to reduce the Challenger form to a mere variety of that species.

With respect to the systematic position of *Caleschara*, opinions may well be divided, its characters at different stages of growth passing from those of a simple *Membranipora*, through *Amphiblestrum* to *Micropora*, with which latter genus it is very closely allied, differing in fact almost solely in the absence of a complete calcareous border round the mature oral orifice. On the whole, and taking the characters from the fully matured condition, I am disposed to agree with Mr. Macgillivray in thinking it worthy at any rate of subgeneric rank.

Caleschara denticulata ?, var. *tenuis* (Pl. XXI. fig. 9).

Character—Zoarium erect, composed of narrow, ligulate, compressed, bilaminar branches. Frontal areas pyriform, separated by very wide, bevelled ridges, and deeply depressed in the middle, where an elliptical aperture is left, occupied in the lower two-thirds by a thick calcareous lamina attached below to the lower border of the aperture, and on each side above to its sides, leaving on either side an elongated fissure. The edges of the lamina toothed, and its surface, as well as that of the interzoœcial ridges, strongly granulated.

Habitat—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

[Var. *foliacea* and *crustacea*, Queenscliff and Victoria, Mr. Watts; Curtis Island, Bass Strait, Captain Warren.]

Family XII. Electrinidæ.

Electrinidæ, d'Orb., 1851, Palæont. Franç., p. 329.
Membraniporidæ (pars), Auctt.

Character—Zoarium erect or incrusting, more or less flexible or subtestaceous. Zoœcia turbinate or subturbinate. Wall punctured. A wide expanding aperture, the

border toothed or furnished with chitinous aculeate spines. One or more chitinous spines of larger size than the rest articulated on the front of the zoœcium below the aperture, or an articulated avicularian process in the same situation. Oœcia when present galeate.

Electra, Lamouroux.

Electra, Lamx., 1816; d'Orb., 1851.
Electrina, *Reptelectrina*, d'Orb.
Flustra, sp., Gmelin; Bosc; Ell. and Soland.; Lamk.; Lister, &c.
Sertularia (pars), Linn., Esper.
Membranipora (pars), Auctt.
Annulipora, Gray.
Eschara (sp.), Pallas.

Character.—That of the Family.

The very peculiar conformation of the species included in the genus *Electra* seems to me amply sufficient to justify its erection into the type of a distinct Family, as proposed thirty years ago by M. d'Orbigny.

Three or four, or perhaps five, species have been described, which may be included in it, viz. :—

Electra pilosa, (Linn.).
,, *verticillata*, Lamx.
,, *triacantha*, Lamx.
,, *bellula*, Hincks.
,, (?) *distorta*, Hincks.

The last must perhaps be regarded as an aberrant form. To these the Challenger collection has made one addition, which, however, differs so widely from the others that it might with some reason be regarded as more than specifically distinct.

Electra cylindracea,[1] n. sp. (Pl. XXXIII. fig. 2).

(*Nec*, *Electra cylindrica*; d'Orb.).

Character.—Zoarium radicate, cylindrical, simple or branched. Zoœcia disposed in annular series round an imaginary axis and very closely crowded. Front pyriform, wide above and much contracted below. Border of aperture thin, smooth, with a straight ascending chitinous spine on each side at the top; and close below these two thick clavate, curved spines or horns. Aperture wide, rounded or oval. Oral orifice very wide,

[1] When I put the appellation at the bottom of the plate, I had overlooked the circumstance that d'Orbigny had already employed the same name "*cylindrica*" for what is probably merely a variety of *Electra verticillata* or of *Electra pilosa*.

close to the summit. At the bottom of the aperture a large upright hollow process with a circular opening surrounded by a very thick granular border and having on one side a large avicularium with an acute falciform mandible, and furnished round the base with several irregularly furcate chitinous processes. Each zoœcium crowned with an avicularium with an acute triangular mandible pointing upwards. Oœcia galeate, each crested with an avicularium on a short cylindrical peduncle; and having a radiate pore in front, immediately above the opening.

Habitat.—Prince Edward Island, 80 to 150 fathoms.

From the densely crowded way in which the cells are disposed, and the manner in which they are concealed by the spines and curious frontal avicularian processes, I have not been able to give an accurate figure of them *in situ*, but those given may perhaps suffice to render the description more intelligible. This is one of the most remarkable forms among the Polyzoa.

Group C. ESCHARINA.

Family XIII. BIFAXARIADÆ.

Character.—Zoarium rigid, continuous or articulated, biserial, variously branched. Zoœcia alternate, closely connate back to back and facing in opposite directions.

The Family here contains the following genera :—

1. *Bifaxaria*, n. gen.
   - § *α. articulatæ.*
     - (1) *Bifaxaria submucronata*, n. sp. (Pl. XIII. fig. 1).
     - (2) *Bifaxaria lævis*, n. sp. (Pl. XIII. fig. 2).
   - § *β. inarticulatæ.*
     - (3) *Bifaxaria corrugata*, n. sp. (Pl. XIII. fig. 3, and Pl. XXIV. fig. 6).
     - (4) *Bifaxaria papillata*, n. sp. (Pl. XIII. fig. 4, and Pl. XXIV. fig. 4).
     - (5) *Bifaxaria minuta*, n. sp. (Pl. XIII. fig. 5).
     - (6) *Bifaxaria reticulata*, n. sp. (Pl. XIII. figs. 6 and 8).
     - (7) *Bifaxaria abyssicola*, n. sp. (Pl. XXIV. fig. 5).
     - (8) *Bifaxaria denticulata*, n. sp. (Pl. XXIV. fig. 3).
2. *Calymmophora.*
   - *Calymmophora lucida*, n. sp. (Pl. XXXII. fig. 3).

1. *Bifaxaria*, n. gen.

Character.—Zoarium continuous or segmented, variously branched, rooted by radical tubes. Zoœcia biserial, alternate, facing bifariously on the two sides, very closely

contiguous. Orifice elliptical from side to side, or semiorbicular or suborbicular. Peristome sometimes subtubular, sometimes deeply immersed. A small circular immersed avicularium on each side of the orifice, sometimes wanting, or replaced by a short, hollow, spinous process. Oœcia, when present, deeply imbedded in the superjacent zoœcium. A raised ridge or keel on the middle of the front, the upper pointed termination of which constitutes a more or less prominent mucro in front of the orifice.

§ *α. articulatæ.*

(1) *Bifaxaria submucronata*, n. sp. (Pl. XIII. fig. 1).

Character.—Zoarium candelabriform, 1 to 2 inches high. Zoœcia subcarinate in front. Orifice horizontal, wide transversely, lower or anterior border submucronate. Surface sparsely punctured in vertical rows. One or two raised lines down the sides. Avicularia small, cup-shaped, circular; mandible semicircular.

Habitat.—Station 122, lat. 9° 5′ S., long. 34° 50′ W., 350 fathoms, red mud.

(2) *Bifaxaria lævis*, n. sp. (Pl. XIII. fig. 2).

Antipathes humilis, Agassiz and Pourtalès, Hassl. Exped., 1874, p. 8, pl. ix. fig. 9.

Character.—Zoarium candelabriform, 1 to 2 inches wide. Zoœcia completely immersed but very convex, square or flattened in front with an acute keel, obscurely punctured. Orifice small, semicircular and slightly sinuate in front. Avicularia small, circular or oval, mandible semicircular, completely immersed some distance from the orifice and on the same level. Oœcia inconspicuous.

Habitat.—Station 214, lat. 4° 33′ N., long. 127° 6′ E., 500 fathoms, blue mud.

§ *β. inarticulatæ.*

(3) *Bifaxaria corrugata*, n. sp. (Pl. XIII. fig. 3, and Pl. XXIV. fig. 6).

Character.—Zoarium continuous; branched bifariously, branches alternate, equidistant, straight, short. Zoœcia from 0″·02 to 0″·03 long, ventricose. Surface strongly wrinkled, with a slender keel in front, and finely perforated only on the front. Orifice transverse, upper border projecting, lower broad with a pointed hook (when perfect) on each side and a smaller one in the middle (being the termination of the keel). A small circular avicularium at each angle of the orifice, and occasionally a large one projecting in the form of a conical papilla from the side of a zoœcium (Pl. XXIV. fig. 6).

Habitat.—Station 122, lat. 9° 5′ S., long. 34° 50′ W., 350 fathoms, red mud.

(4) *Bifaxaria papillata*, n. sp. (Pl. XIII. fig. 4, and Pl. XXIV. fig. 4).

Character.—Zoarium branched bifariously, branches opposite, curved, ascending, with short secondary branches. Zoœcia urceolate, square in front with a slight mesial keel and a ridge on each side, all three terminating at the anterior border of the orifice in small spinous processes. Anterior wall entire; two rows of distant punctures on the sides, one of three or four small ones close to the border, and the other of as many larger ones down the middle of the side. Oral angular avicularia very minute and often absent altogether. On the older zoœcia a papilliform avicularium with an elliptical or subtriangular mandible. Oœcia deeply immersed, often with a very large conical eminence on both sides, on the under side of which is an avicularium with an elliptical mandible.

Habitat.—Station 196, lat. 0° 48′ S., long. 126° 58′ E., 825 fathoms, hard ground.

Having much the same habit as *Bifaxaria corrugata*, the present differs from that form,—1. In its much smaller size; 2. In having the branches curved instead of straight; 3. In the branches being opposite, and also in that the primary give off secondary branches; and 4. In the shape of the zoœcium, which is flattened or square in front and imperforate, though with punctures on the sides. In the older cells one of these punctures appears to become elevated into a papilliform avicularium, which in some cases attains an enormous development on the sides of the oœcia and sometimes on one of the ordinary zoœcia (Pl. XXIV. fig. 4*d*).

The lateral puncta are concealed under the epitheca and were overlooked when the drawing was made (Pl. XIII. fig. 4).

(5) *Bifaxaria minuta*, n. sp. (Pl. XIII. fig. 5).

Character.—Zoarium very small (probably); zoœcia fusiform; orifice semicircular; a circular immersed avicularium on each side close to the orifice. A thin ridge down each side towards the front and a septal ridge between the two series of zoœcia; five or six small punctures close to the septal ridge.

Habitat.—Station 70, lat. 38° 25′ N., long. 35° 50′ W., 1675 fathoms, Globigerina ooze.

The only specimen in the collection is a very small fragment, including the lower part of the zoarium and the bundle of radical fibres by which it was affixed to *Globigerina* shells. The state of the specimen does not afford any clue to the habit of the growth, but it was doubtless of only small size.

(6) *Bifaxaria reticulata*, n. sp. (Pl. XIII. figs. 6 and 8).

Character.—Zoarium? Zoœcia fusiform, orifice orbicular, with a minute mucro in front, afterwards tubular, and eventually furnished with a wide lip on each side. A raised septal line between the series. In the older zoœcia a short spine in the angle at each side of the orifice. A row of five or six punctures on each side close to the septal ridge.

Habitat.—Station 13, lat. 21° 38′ N., long. 44° 39′ W., 1900 fathoms, Globigerina ooze.

The wall of the zoœcial cells is very finely cancellated or reticulated (fig. 6*b*).

This species is also represented only by two or three small fragments, so that what its general habit may be is uncertain.

(7) *Bifaxaria abyssicola*, n. sp. (Pl. XXIV. fig. 5).

Character.—Zoarium (about 1 inch high) slender, cylindrical, branched, arising from a bundle of radical fibres. Zoœcia completely immersed. Surface coarsely rugose; orifice immersed, narrow, transverse, lower or anterior lip slightly prominent. Avicularia small, disposed in a single row on either side, on slightly elevated rostriform papillæ. Mandible semicircular pointing upwards or sideways.

Habitat.—Station 253, lat. 38° 9′ N., long. 156° 25′ W., 3125 fathoms, red clay.

Specimen very imperfect.

(8) *Bifaxaria denticulata*, n. sp. (Pl. XXIV. fig. 3).

Character.—Zoarium 1 to 1·5 inches high, irregularly branched in one plane. Zoœcia, though bifarious, tend to face one way. Surface closely punctured in the younger zoœcia, wrinkled in the older. Orifice horizontal, with a prominent bifid lower or anterior lip. A small avicularium looking inwards on one side of the median sinus of the lower lip, with an acute triangular mandible pointing upwards.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

2. *Calymmophora*, n. gen.

Character.—Zoarium continuous, irregularly branched; biserial; the zoœcia alternate, placed back to back facing in opposite directions, pyriform, squarely truncated at the top, with a hollow conical process at each angle, often supporting a small avicularium. Orifice large, orbicular, with a wide notch in front, terminal (looking directly upwards). Oral valve semicircular, curved transversely, with numerous perforations. Wall exceed-

ingly delicate, with a very slender median and two lateral ridges, and a row of very distant pores on each side and a few of smaller size on the sides and below the orifice. Oœcium galeriform, completely immersed in front of the superjacent zoœcium, and covered with the general epithecal membrane, with which the entire growth is enveloped as in a loose veil.

Calymmophora lucida, n. sp. (Pl. XXXII. fig. 3).

Character.—The only species.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

One great peculiarity in this form is that the external chitinous membrane, or epitheca as it may be termed, which is in fact the remains of the original germinal membrane of which the incipient budding zoœcia are solely formed, is completely detached, except at a few points, from the proper calcified wall, and forms a universal beautifully transparent veil over the entire growth, passing as it were uninterruptedly from one zoœcium to another, and enclosing the oœcia. Another special characteristic is the completely terminal position of the mouth, the oral valve constituting a curved lid, which when open is thrown forwards.

The growth is everywhere as transparent as glass, so that the whole internal economy is visible. The polypide is of comparatively small size compared with the capacity of its habitation, and presents nothing unusual, except that there is no ventricular diverticulum, nor any distinct œsophagus nor pharynx. The retractor muscles do not appear to be either striated or nucleated, and there is no appearance of a so-called funiculus, nor in fact of any structures within the cavity beyond the retractor muscular fibres.

The extreme delicacy and transparency of the textures make it advantageous to employ some colouring agent in the examination.

Family XIV. Salicornariadæ.

Salicornariadæ (pars), Bk., Brit. Mus. Cat.
Salicornariidæ (pars), Bk., Crag Polyz.
Salicornaridea (pars), Reuss.
Cellarieæ (pars), Smitt.
Cellaridæ, *Escharellinidæ*, &c., d'Orb.
Cellariidæ, Hincks, &c.

Character.—Zoarium erect, radicate or fixed; simple, branched, or lobed; segmented or continuous; cylindrical, with the cells disposed round an imaginary axis, or compressed and bilaminar. Surface areolated. Zoœcia completely immersed, each corresponding to an area; front depressed, usually concave. Orifice crescentic, semi-

circular, or elliptical. Oœcia inconspicuous, opening at or near the summit of the area above the orifice. In the decalcified condition the interareolar septa exhibit a delicate chitinous probably tubular filament apparently continuous throughout the segment; and on each side of the oral orifice a slender curved chitinous rod or trabecula, which sometimes unite so as to form a complete or incomplete ring. Avicularia usually present, either vicarious or intercalated.

The Family Salicornariadæ, as thus constituted, appears to be a very natural one. It includes besides *Salicornaria* or *Cellaria*, the genus *Melicerita* of M. Milne-Edwards, the close relationship of which to *Salicornaria* has also been perceived by Mr. Waters.[1]

Under the name *Salicornaria* I have included all the cylindrical forms, though strongly inclined to separate *Salicornaria magnifica* from the rest, on account of its unjointed branched zoarium, and the absence, so far as I have been able to perceive, of any avicularian organs.

As in very many other cases, the chitinous elements of the skeleton will in this Family be found of the utmost value in diagnosis, as affording the most distinct and invariable characters. Among these elements are included, besides the opercula and avicularian mandibles:—1. A delicate, sometimes distinctly tubular filament, running along the interareolar septa, and affording probably a channel through which the extension and calcification of the septa are effected. This filamentary network appears to be continuous throughout the branch or internode, and the network formed by it should be regarded as zoarial rather than as appertaining to the individual zoœcia enclosed in the meshes.

2. A second chitinous element, peculiar, so far as I am aware, to this Family, consists in the delicate rods or trabeculæ on either side of, or completely surrounding the orifice and its operculum, to which the rods or ring afford support. It may be added that these trabeculæ or the analogous chitinous ring are plainly visible, in many cases without any previous decalcification. This is especially seen in *Salicornaria magnifica* and *Melicerita atlantica*. They appear to lie beneath the common epitheca and not to form mere thickenings of it.

A further peculiarity, common, so far as I know, to the whole Family, is the existence of a rounded apparent opening at each lower angle of the operculum, and which in the descriptions of several species are termed "foramina." Subsequent examination, however, seems to show that these marks are not really openings, but in all probability merely the optical expression of the bases of short conical projections on the dorsal surface of the operculum—a sort of levers—for the attachment of the occlusor muscles.

[1] *Quart. Journ. Geol. Soc.*, August, 1881, p. 332.

The Family here contains the following genera :—

§ 1. *cylindricæ.*

1. *Salicornaria.*

α. simplices.

(1) *Salicornaria clavata*, n. sp. (Pl. XII. fig. 8).

β. articulatæ.

(*a*) *tubulatæ.*

(2) *Salicornaria simplex*, n. sp. (Pl. XXXIII. fig. 8).

(*b*) *nodatæ.*

(3) *Salicornaria variabilis*, n. sp. (Pl. XII. figs. 3–9).
(4) *Salicornaria divaricata*, n. sp., woodcut 4.
(5) *Salicornaria bicornis*, n. sp. (Pl. XXXIII. fig. 9).
(6) *Salicornaria dubia*, n. sp. (Pl. XII. fig. 2).
(7) *Salicornaria malvinensis*, Busk (Pl. XII. figs. 1, 5, 7).
(8) *Salicornaria tenuirostris*, Busk.
(9) *Salicornaria gracilis*, Busk.

γ. inarticulatæ.

(10) *Salicornaria magnifica*, n. sp. (Pl. XII. figs. 4, 6).

§ 2. *compressæ.*

2. *Melicerita.*

(1) *Melicerita atlantica*, n. sp. (Pl. XIV. fig. 1).
(2) *Melicerita dubia*, n. sp. (Pl. XXXIII. fig. 10).

§ 1. *cylindricæ.*

1. *Salicornaria*, Cuvier.

Salicornaria, Cuvier; Johnst.; Brit. Mus. Cat.; Stoliczka, &c., &c.
Salicornia, Schweigger.
Cellaria (pars) Lamx.; Solander, &c.
„ Lamk.; Smitt; d'Orb.; Hincks, &c.
Farcimia, Fleming.
Cellularia (pars), Pallas; Bruguière, &c.
Glauconome (pars), Münster.
Vincularia (pars), d'Orb.; Roemer, &c.

Character.—Zoarium radicate, simple or branched, articulated or continuous; cylindrical, with the cells disposed round an imaginary axis; with or without avicularia

When articulated the internodes are connected either by short straight tubes, or with the intervention of a convoluted knot of slender tubules.

The recent species of this genus, as above defined, with which I am acquainted, are about fifteen to seventeen in number, and they admit of being conveniently and more or less naturally grouped as under :—

α. simplices.—In which the zoarium is simple, or composed, as it may be said, of a single segment, from which, however, loosely connected offsets sometimes spring irregularly, attached to the parent stock either by ordinary clasping filaments, or sometimes by a single, rather long tube arising from the front of a zoœcium, when the young offset or branch may be regarded as homologous with the chitinous tubes resembling radical fibres presented in several species, which spring in a similar manner from the front or other part of a cell in other species of *Salicornaria*, as, notably, *Salicornaria pilosa*, Kirch., and *Salicornaria bicornis*, Bk., as well also as in many other species belonging to several genera. The only species in which this condition is very distinctly shown is *Salicornaria clavata*, n. sp.; there is, however, a small form from the Adriatic, termed by M. Costa *Salicornaria gracilis*, but which seems to me to be distinct, in which the same habit would appear to be present.

β. articulatæ.—In which the internodes are connected by elastic or flexible joints, and always arise in pairs, so as to constitute a dichotomous growth. These forms may again be subdivided into—(*a*), those in which the bond of union between the segments consists of more or less numerous, short, thick-walled, chitinous tubes which are continuous at either end with the delicate endocyst of the terminal cells in the superior and inferior internodes; and (*b*), those in which the connection is effected with the intervention of what Prof. Smitt terms a "knot of intricated radical tubes." The precise mode of connection between this "knot" and the three internodes between which it forms the bond of union, I have not been able satisfactorily to determine, but so far as I can perceive one or two tubes arise from the summit of the inferior internode, and form an intricate plexus, which is lodged between the two superior segments, and gives off a single tubule to each. The junction, consequently, so far as the chitinous element is concerned, appears to be slight, though highly elastic. In most of the species thus furnished it should, moreover, be remarked that the calcareous walls of the contiguous internodes above and below are very closely applied to each other, so as to appear continuous, but I have not met with any case in which they are really so. The species belonging to this category are much more numerous than those in the other, and for the most part apparently confined to the southern hemisphere, the only apparent exception to this being *Salicornaria johnsoni*, which occurs also in the northern.

It is worthy of remark that this difference in the manner of articulation appears to be connected with other characters distinctive of the respective groups.

Speaking generally, the species of *Salicornaria* may also be grouped into those in which the areolation is fundamentally rhomboidal, and those in which it is strictly hexagonal. In both, in certain states, pyriform areas are common, more especially in the younger parts; and the rhomboidal areas very commonly become hexagonal by the truncation of the upper and lower angles, whilst in the truly hexagonal forms the upper and lower angles of the area are acute, and it is very rare, I think, to meet with the true hexagon in a rhomboidal species; but this occurs sometimes in *Salicornaria sinuosa*. In connection with these two fundamental types of areolation, it would appear that the rhomboidal form occurs in those species in which the articulation is by straight tubes, whilst the true hexagonal areolation is characteristic of those in which the nodular connection exists.

The known species in which the areolation is fundamentally rhomboidal and the articulation tubulate, are :—

(1) *Salicornaria farciminoides*, Cuvier.
(2) *Salicornaria sinuosa*, Hasswell.
(3) *Salicornaria simplex*, n. sp. (Pl. XXXIII. fig. 8).
? (4) *Salicornaria crassa*, n. sp.
? (5) *Salicornaria hirsuta*, Kirchenpauer.

Whilst those in which the areolation is originally hexagonal and the articulations nodular are :—

(6) *Salicornaria variabilis*, n. sp.
(7) *Salicornaria aciculata*, n. sp.
(8) *Salicornaria bicornis*, Busk.
(9) *Salicornaria dubia*, n. sp.
(10) *Salicornaria malvinensis*, Busk.
(11) *Salicornaria tenuirostris*, Busk.
(12) *Salicornaria johnsoni*, Busk.
(13) *Salicornaria johnsoni*, var. *gracilis*, Busk.
? (14) *Salicornaria hexagonalis*, n. sp.

γ. *inarticulatæ*.—The only cylindrical branching form with which I am acquainted, in which the growth of the branches is absolutely continuous and without the least indication of segmentation is :—

(15) *Salicornaria magnifica*,

which is further distinguished by the entire absence of avicularia.

As regards the bathymetrical and geographical distribution of the Challenger Salicornariadæ, it may be stated that the former extends from 5 to 1950 fathoms; and as

regards the latter, that the North Atlantic region afforded 2 species; the South Atlantic, 4 species; the South Indian or Kerguelen region, 2–3 species; Australian, 2 species. None seem to have occurred in the Philippine or Pacific regions.

a. simplices.

(1) *Salicornaria clavata*, n. sp. (Pl. XII. fig. 8).

Cellaria fistulosa, Macgillivray, Nat. Hist. Vict.; Dec. v. p. 47, pl. xlix. fig. 1 (*nec* Linn.).
" " var. *australis*, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. xiii. p. 368, 1884.

Character.—Zoarium radicate, either simple and clavate, or with irregular loosely attached branches or offsets. Areas rhomboidal or sometimes truncato-hexagonal. Surface smooth. Orifice crescentic, lower lip prominent. Avicularia intercalated, mandible semicircular, 0″·002 × ·0055, with a central opening and subbasal tubercle. Operculum, 0″·006 × ·0045, semicircular, crescentic below, with a wide granulated band.

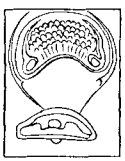


Fig. 5.—*Salicornaria clavata.*

Habitat.—Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud. Station 151, off Heard Island, 75 fathoms, volcanic mud. Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells. Station 163B, off Port Jackson, 35 fathoms, hard ground. Station 304, lat. 46° 53′ S., long. 75° 12′ W., 45 fathoms, green sand. Prince Edward Island.

[Queenscliff, Portland, Maplestone.]

β. articulatæ.

(α) tubulatæ.

(2) *Salicornaria simplex*, n. sp. (Pl. XXXIII. fig. 8).

Character.—Zoarium 1 to 3 inches high, composed of tolerably thick internodes, from $\frac{1}{4}$th to $\frac{1}{2}$ inch long and pretty uniform in length in the same zoarium; branching dichotomously. Areas (in mature parts) rhomboidal or sometimes hexagonal, remarkably regular and uniform. Surface (beneath the epitheca), finely granular. Orifice nearly central, suborbicular, with two pointed denticles above and below. Operculum arcuate, 0″·0055 × ·005, with a branched chitinous support on each side; the lateral trabeculæ meet below the orifice and from the transverse portion three pointed filaments depend. Avicularia (when present) vicarious, with a very large semicircular mandible 0″·0075 × ·0135 pointing upwards.

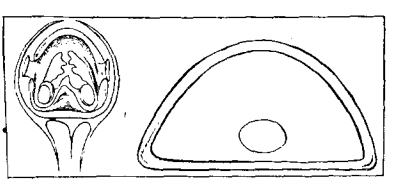


Fig. 6.—*Salicornaria simplex.*

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

[New Zealand, Colenso.]

This fine species is at once recognisable by its very peculiar oral chitinous armature, which is quite unlike that of any other species. It is remarkable also for the extreme regularity in size and disposition of the areolation, which is for the most part strictly rhomboidal, but sometimes, as in other cases, becomes hexagonal. In the perfect state the entire surface is covered with a thin epitheca which renders it quite smooth, but when this is removed the aspect is very finely granular. A curious circumstance should be noticed, viz., that in many instances, throughout the whole zoarium, not a single avicularium will be found, so that after examining several specimens of the Challenger collection, I had met with none at all, and had concluded, therefore, that the species was altogether unarmed; but upon examining some fine specimens from New Zealand, where they were procured by Mr. Colenso, to my surprise I found that it did possess very large vicarious ones. So that the name "simplex" I had applied to the form became far less appropriate, though it is perhaps partially justified by the extreme regularity and simplicity of the sculpture. Another peculiarity, so far as I am aware, of the present species, is the fine annulation of the chitinous tubes connecting the segments.

(*b*) *nodatæ.*

(3) *Salicornaria variabilis*, n. sp. (Pl. XII. figs. 3 and 9).

Character.—Zoarium several inches high, composed of elongated unequal internodes, usually incrassated about the middle, and varying much in diameter; joints nodular. Areas rhomboidal, truncato-hexagonal, pyriform or hexagonal; interior ridges inconspicuous or absent; surface smooth. Orifice crescentic, with a prominent lower lip and well-marked internal articular denticles below. Operculum crescentic, with a strongly marked granulated crescentic areola, 0″·005 × ·003; trabeculæ short and small. Avicularia vicarious, mandible subtriangular, with an acuminate membranous point and a central foramen 0″·007 × ·006.

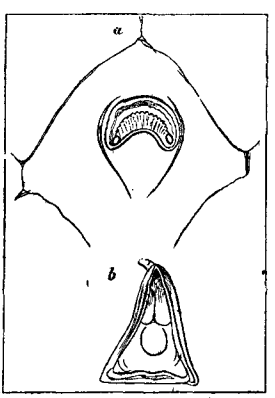


FIG. 7.—*Salicornaria variabilis.*
a, Chitinous areolar filament; *b*, mandible.

Habitat.—Station 304, lat. 46° 53′ S., long. 75° 12′ W., 45 fathoms, green sand. Station 314, lat. 51° 35′ S., long. 65° 39′ W., 70 fathoms, sand. Station 149B, Kerguelen Island, 25 fathoms, volcanic mud.

(4) *Salicornaria divaricata*, n. sp. (woodcut fig. 8).

Character.—Zoarium slender, growth divaricate, 1 to 2 inches high; articulations nodular. Areas hexagonal, elongate; surface smooth or very faintly granular; interior ridges elevated, not united below nor above. Orifice crescentic, with a prominent lower lip. Operculum crescentic, rounded above, with strongly bordered angular apparent foramina 0″·004 × ·0025. Avicularia vicarious; mandibles spear-shaped, pointed, sometimes acicular, 0″·008 × ·005.

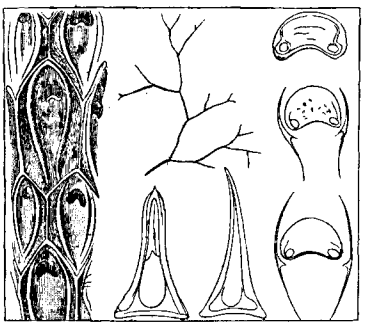


FIG. 8.—*Salicornaria divaricata.*

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

[Port Philip, Wilson.]

I had not recognised the distinction of this species in time to insert a figure in the plate and have therefore introduced it in the accompanying woodcut. It is distinguished readily enough by its general habit when good specimens are available. The operculum is comparatively small, and the avicularian mandible is in some cases acicular, in others more lanceolate. It belongs to the same class of mandibles as those of *Salicornaria malvinensis* and *Salicornaria dubia.*

(5) *Salicornaria bicornis*, Busk (Pl. XXXIII. fig. 9).

Salicornaria tenuirostris, var. a. *bicornis*, Brit. Mus. Cat., vol. i. p. 17, pl. lxiii. fig. 4.
(?) *Cellaria tenuirostris*, Macgilliv., Nat. Hist. Vict., Dec. v., p. 49, pl. xlix. fig. 3*c*.

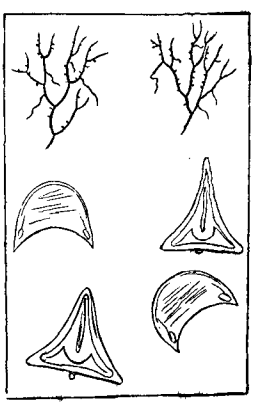


FIG. 9.—*Salicornaria bicornis.*

Character.—Zoarium 1 to 2 inches high, slender, dichotomous; internodes curved; joints nodular; numerous clasping filaments arising from the front of the zoœcia. Areas hexagonal; surface smooth; lateral ridges strongly developed and usually terminating above in a projecting angle. Orifice crescentic; lower lip very prominent in the middle, with a depression below it. Operculum crescentic, with the lower angles produced, acute, 0″·0045 × ·003 Avicularia intercalated ?, with a projecting rostrum above and a triangular mandible, 0″·0055 × ·0055 with an acute incurved apex and short median columella.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

[Bass Strait, 45 fathoms, Voy. of Rattles.; Tasmania, Hooker.]

(6) *Salicornaria dubia*, n. sp. (Pl. XII. fig. 2).

Character.—Zoarium from 1 to 2 inches high, slender, dichotomous, divaricate; internodes pretty equal; joints nodular. Areas hexagonal; interior ridges strong, meeting above and below so as to circumscribe an oval space; surface granular. Orifice subcrescentic. Operculum subcrescentic or semicircular, 0″·006 × ·0035–·0040. Avicularia vicarious; mandible spear-shaped, with an incurved acuminate point, 0″·010 × ·006.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

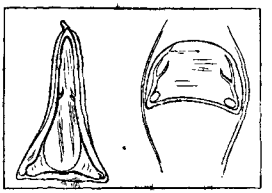


FIG. 10.—*Salicornaria dubia.*

Allied to *Salicornaria malvinensis* in the characters of the avicularian mandible, but differing in the uniformly granular surface and the strongly developed interior ridges on the front. The operculum also is more strictly semicircular, instead of sub-elliptical as in *Salicornaria malvinensis*, and the chitinous lateral supports in the operculum are furcate, and not continued across as in *Salicornaria malvinensis*. The mandible also is smaller and slenderer. It might probably, however, be regarded as a variety of this species.

(7) *Salicornaria malvinensis*, Busk (Pl. XII. figs. 1, 5, 7).

Salicornaria malvinensis, Bk., Brit. Mus. Cat., vol. i. p. 18, pl. lxiii. figs. 1, 2.
Cellaria malvinensis, Waters, Bryoz. S. W. Victoria, Quart. Journ. Geol. Soc., August 1881, p. 321, pl. xiv. fig. 3.

Character.—Zoarium dichotomous, 2 to 3 inches high, composed of unequal internodes, sometimes much elongated, sometimes short and thick; joints nodular. Areas hexagonal

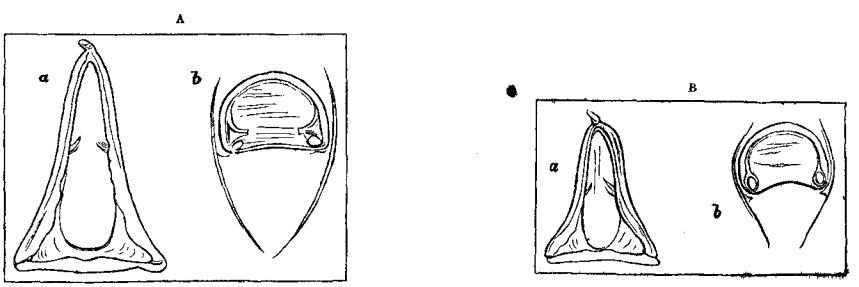


FIG. 11.—*Salicornaria malvinensis.* (Two varieties). A, Larger form; B, smaller form.

or pyriform when young; surface smooth, no interior ridges. Orifice crescentic, transversely elongate. Operculum semicircular or subcrescentic, angular, apparent foramina

small. Avicularia vicarious; mandible spear-shaped, with a very wide base and large inferior foramen; apex acuminate, incurved, 0″·013 × ·008 to 0″·0095 × ·008.

Habitat.—Station 149D, Royal Sound, Kerguelen, 28 fathoms. Off Marion Island, 50 to 75 fathoms. Station 304, lat. 46° 53′ S., long. 75° 12′ W., 45 fathoms, green sand. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel. Station 176, lat. 18° 30′ S., long. 173° 52′ E., 1450 fathoms, Globigerina ooze. Port William, Falkland Islands; 5 to 10 fathoms.

[South Patagonia, Falkland Isles, Strait of Magellan, Darwin; Mount Gambier (fossil), Waters.]

Salicornaria malvinensis presents considerable diversity of habit in different localities, so much so, that at first I had designated one of its varieties, characterised by the shortness and thickness of the internodes and the comparatively large size of the orifice, *Salicornaria megastoma;* but further examination has shown no essential differential characters between this and the forms with elongated and slenderer internodes. In the variety from Station 315 (fig. 7) a further exception to the more usual character is seen in the granular surface of the interareolar septa, when the epitheca has been removed.

(8) *Salicornaria tenuirostris*, Busk.

Salicornaria tenuirostris, Bk., Brit. Mus. Cat., vol. i. p. 17, pl. lxiii. fig. 3.
Cellaria tenuirostris, Smitt, Florid. Bryoz., vol. ii. p. 4 pl. i. figs. 57–59.

Character.—Zoarium slender, small, dichotomous; joints nodular. Areas hexagonal, distant; interior ridges united below; surface subgranular. Orifice nearly central, crescentic or semicircular. Operculum semicircular, lower border nearly straight, 0″·005 × ·003. Avicularia vicarious; mandible spear-shaped, 0″·009 × ·005, attenuated upwards, with a central columella and acuminate point.

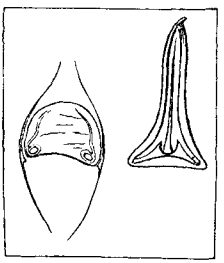


FIG. 12.—*Salicornaria tenuirostris.*

Habitat.—Station 314, lat. 51° 35′ S., long. 65° 49′ W., 70 fathoms, sand.

[Bass Strait, Voy. of Rattles.; Gulf of Florida, 58 to 60 fathoms, Smitt; Queenscliff, Victoria, Müller; Port Philip, Wilson.]

The mandible in *Salicornaria tenuirostris* is sometimes smaller and shorter, when it is scarcely distinguishable from that of *Salicornaria bicornis*, with which the species appears to be closely related. But the operculum differs considerably, and by this alone the two may be distinguished. The lateral trabeculæ, also, in *Salicornaria tenuirostris* are much longer than in *Salicornaria bicornis*.

(9) *Salicornaria gracilis*, Busk.

Salicornaria gracilis, Bk., Brit. Mus. Cat., vol. i. p. 17, pl. lxiii. fig. 3.
Salicornaria punctata, Bk., Voy. of Rattles., vol. i. p. 366.
Cellaria gracilis, Macgilliv., Nat. Hist. Vict., Dec. v., p. 50, pl. xlix. fig. 4.
(?) „ *attenuata*, d'Orb.
(?) „ *tenella*, Lamk.
(?) „ *salicornioides*, Savigny, Egypte, pl. vi. fig. 7.

Character.—Zoarium slender, small; joints nodular, dichotomous. Areas hexagonal; internal ridges prominent; surface granular. Orifice semicircular or subcrescentic. Operculum semicircular, sometimes with a crescentic granulated area, 0″·0035 × ·0025. Avicularian mandible large, semicircular, more or less angular above.

Habitat—Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

[Off Cumberland Island, Cape Capricorn, Voy. of Rattles.; Queenscliff, Sealer's Cove, Müller.]

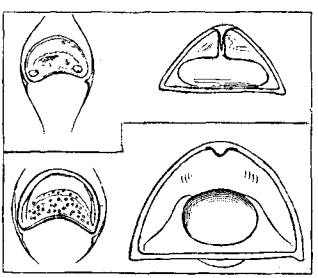


FIG. 13.—A, *Salicornaria gracilis*; B, *Salicornaria johnsoni*.

At one time I was inclined to regard *Salicornaria gracilis* as merely a variety of *Salicornaria johnsoni*, a species to which it bears, in some respects, a strong resemblance, and it would be difficult, from the external characters alone, to decide the question. Close re-examination, however, more especially of the chitinous parts, shows that the two are quite distinct. The accompanying figures will show the differences that exist in the opercula and mandibles of the two forms, whilst at the same time they will demonstrate how closely the corresponding parts represent each other. But there is another particular in which the specific diversity is plainly represented. In the Atlantic *Salicornaria johnsoni* the articulations are composed of straight tubes, as they are in *Salicornaria farciminoides*, *Salicornaria sinuosa*, and some others belonging to the northern hemisphere, whilst in the Australian form the joints are what I have termed "nodular,"—the more common mode as already observed in the southern species of the genus.

γ. inarticulatæ.

(10) *Salicornaria magnifica*, n. sp. (Pl. XII. figs. 4, 6).

Character.—Zoarium radicate, 1 or 2 inches high, continuous, branched on one side only, at very uniform distances, branches sometimes forked at the extremity, slightly compressed. Areas oblong or elongated hexagons, arched above, and from 0″·03 to ·05

long, by 0″·02 or ·025 wide; within the area a slight ridge,[1] forming a very obscure secondary area; surface nearly even. Orifice placed above the centre, semicircular, with a straight, entire, lower border. Operculum semicircular, 0″·008 × ·0055. Surface beneath the overlying epitheca finely granular. Avicularia, 0.

Habitat.—Station 323, lat. 35° 39′ S., long. 50° 47′ W., 1900 fathoms, blue mud. Station 122, lat. 9° 5′ S., long. 34° 50′ W., 350 fathoms, red mud. Station 157, lat. 53° 55′ S., long. 108° 35′ E., 1950 fathoms, Diatom ooze. Station 13, lat. 21° 38′ N., long. 44° 39′ W., 1900 fathoms, Globigerina ooze.

This beautiful species differs from all the other cylindrical *Salicornariæ*, in its being continuous and without the least trace of any articulation, notwithstanding the circumstance that it is rooted by radical fibres, and not by a calcareous base. In the apparently total absence also of any avicularian organs, it departs from all other *Salicornariæ*, at present known, as well as in the apparent want of any ovarian pores. It differs also in the arrangement of the oral chitinous armature, inasmuch as that the lateral trabeculæ are represented by a continuous ring, on which a slight projection on each side serves for the articulation of the operculum. In many respects the species appears to constitute a transition between *Salicornaria* and *Melicerita*.

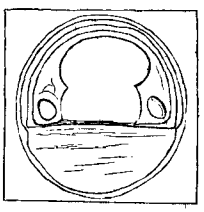


FIG. 14.—*Salicornaria magnifica.*

It is a form also of considerable interest with respect to its habitat. Of the four Stations at which it was procured, three belong to the Atlantic and one to the South Indian or Kerguelen region, and in three out of the four it came up from a depth of 1900 fathoms, and in the other probably from one of 400 fathoms. It may be regarded therefore distinctively as a deep-water form, and connected with this it will be as well to describe its common mode of attachment.

The disposition of the radicells in this case presents a curious peculiarity. The bundle of fibres constituting a rather long flexible stem is formed by separate tubules, which issue from the lower part of a certain number of the lowermost six or eight zoœcia. But the lowermost of these, or what might be termed the primary zoœcium, differs apparently in no respect from the rest. The growth may be said to start at once in its complete form. Immediately below this primary cell the tubes suddenly coalesce in an irregular manner, and at the same time become flattened out into broad ligulate bands which, after they have attained a length of an inch or more break up again into an inextricable tuft of filaments of the most unequal size, which ultimately terminate in irregularly beaded fibres. Thus there is formed a spongy mass, in the interstices of which all kinds of small bodies are entangled, such as *Globigerinæ* and other Foraminifera, sponge spicules, &c. But it should be noted that in more than one respect the radical

[1] Omitted in the figure.

tubes and fibres in this case differ from those of the deep water *Bicellariæ* and other abyssal forms, in the circumstance that they have a tendency to coalesce and form flattened bands as above stated, in something the same way as in *Kinetoskias*. And it should also be remarked that in the present case the ultimate fibrils are not individually affixed to separate particles, but rather by their interlacement form a soft spongy or felted mass, the interstices of which are filled and, as it were, weighted by the foreign substances contained in the meshes, or even, as sometimes may be seen, received into actual pouches formed by the flattened membranous bands.

The case affords a striking instance of the active organizing force inherent in the apparently amorphous chitinous substance of the radical tubes, which must be supposed, even down to the finest, to be lined by an active living tissue of some kind,—each segment in fact of every fibre being an actively living zooid as truly as are the zoœcia themselves.

§ 2. *compressæ*.

2. *Melicerita*, Milne-Edwards.

Melicerita, Milne-Edw., Ann. d. Sci. Nat., vol. vi. p. 26;
d'Orb. Reuss, Stoliczka, Busk, &c.
Melicertina, Ehrenb.
Ulidium, Searles Wood.
(?) *Latereschara*, d'Orb.
Cellaria (sp.), Waters.

Character.—Zoarium compressed, bilaminar, rigid, lobate, ligulate, or foliaceous; articulated or continuous. Zoœcia usually disposed in transverse rows.[1] Surface areolated. Area rhomboid or hexagonal. Orifice subcentral, semicircular, or oblong; border entire, with two articular teeth below and sometimes also above. Operculum corresponding in form to the orifice, supported by a chitinous ring, incomplete above.

In the conformation of the zoœcia and general structure of the zoarium there is no essential difference between *Melicerita* and *Salicornaria*, the two, as I have remarked in the "Crag Polyzoa" (p. 70), very closely corresponding. The main distinction between the two forms consists solely, as it would seem, in the compressed habit of the one and the cylindrical form of the other. The transverse arrangement of the cells and the absence of segmentation, if this be real, are perhaps characters insufficient of themselves to entitle *Melicerita* to the place of a distinct genus in the Family Salicornariadæ.[2]

[1] The disposition of the cells in transverse series is the main character upon which the genus was founded by M. Milne-Edwards, but it is not one that can be regarded as of primary importance, since the same disposition occasionally obtains in several species of *Salicornaria*, and notably in *Salicornaria malvinensis*, in some part or other of the zoarium.

[2] In a valuable paper on the Fossil Chilostomatous Bryozoa from South-West Victoria, Australia, published in the *Quarterly Journal of the Geological Society*, vol. xxxviii. p. 322, 1881, Mr. A. W. Waters observed that *Melicerita angustiloba*,

Up to the present time the only known species referrible to *Melicerita* were two, or perhaps three, fossil forms, viz. :—

1. *Melicerita charlesworthii*, Milne-Edwards.
2. *Melicerita angustiloba*, Busk.
(?) 3. *Melicerita* (*Latereschara*) *achates*, d'Orbigny.

Of these the first two are probably of Miocene age, belonging one to the Coralline Crag of England, and the second to beds, supposed to be of the same age, in Australia and New Zealand. M. d'Orbigny's species, if it be properly referred to the genus, belongs to the Cretaceous epoch. The discovery, therefore, of living forms at a considerable depth in the South Atlantic is one of very great interest, though they do not, so far as I can perceive, present any advance in organisation.

(1) *Melicerita atlantica*, n. sp. (Pl. XIV. fig. 1).

Character.—Zoarium simple or lobate, probably radicate; about 0″·25 wide. Areas hexagonal, usually arched above. Surface finely granular, sloping gradually and evenly to the orifice, which in the fresh state is surrounded at some distance by a slender chitinous ring incomplete above. Orifice large, central, suboval or oblong; lower border straight or slightly concave. Peristome thickened, with a minute internal denticle on each side below, none (?) above. Oœcial orifice a crescentic slit beneath the upper angle of the area. Avicularia 0.

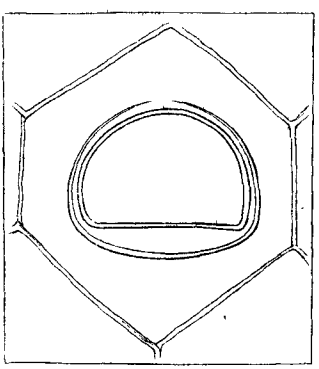


Fig. 15.—*Melicerita atlantica.*

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, hard ground.

In the narrow or ligulate form of the zoarium, *Melicerita atlantica* resembles *Melicerita angustiloba*, though it is somewhat broader. But in essential particulars the two differ very widely. In *Melicerita angustiloba* the lower border of the orifice is deeply notched on either side, or may be said to present a wide, straight-edged mucro. In it also, as in *Melicerita charlesworthii*, there are two large internal denticles above,

Bk., appears to be articulated, and that "it should be united with *Cellaria* (*Salicornaria*)," thus concurring in the view I had expressed. But it is by no means on account of the zoarium being articulated that this union should be made. It would be impossible to separate generically *Melicerita charlesworthii*, Milne-Edw., from *Melicerita angustiloba* and *Melicerita atlantica*, n. sp., the former of which is foliaceous and undoubtedly continuous, whilst the latter two may or may not be so The mere fact of articulation, therefore, is of little consequence, nor in fact is it so in the genus *Salicornaria* itself.

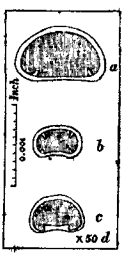
and probably also below, though the latter are either concealed by, or more probably coalescent with, the broad mucro. But in *Melicerita atlantica* the lower border of the orifice is quite even, without any appearance of a mucro, nor have I been able to detect any upper internal denticles, indeed I am not quite sure of their existence even below. If of small size they may, however, be concealed by the chitinous investment and operculum.

The relative dimensions of the zoœcial areas in the three species are as under:—

Melicerita charlesworthii, . . .	0″·015 × ·010
Melicerita angustiloba, ...	0″·022 × ·015
Melicerita atlantica, ...	0″·025 × ·035

and as the size of the areas in all three species appears to be remarkably uniform, these dimensions afford an additional differential character of considerable value. They also show that, so far as size is concerned, the recent form shows an advance upon its Miocene predecessors.

The accompanying figures show the relative proportion of the orifice in three species, drawn to scale and magnified about 50 diameters.



a. Melicerita atlantica.
b. Melicerita charlesworthii.
c. Melicerita angustiloba.

N.B.—As the only specimen of *Melicerita atlantica* is quite fragmentary, the account of its habit of growth is of course imperfect; nor is it possible to say how it is rooted, whether radicate or fixed, but most probably, like the rest of the Salicornariadæ, it is radicate.

(2)? *Melicerita dubia*, n. sp. (Pl. XXXIII. fig. 10).

Character.—Zoarium compressed, bilaminate, erect; composed of broad branching lobes of unequal width. Surface divided into uniform rhomboidal or hexagonal areas, angular at top and bottom, bounded by thick granular continuous ridges, and disposed in transverse series. Front much depressed, with a central rounded elliptical aperture, having a thick beaded or granular border, and the upper third occupied by a semicircular operculum; the lower part membranous. A few vicarious avicularia on the edges of the branches or lobes, with an obtuse mandible pointing upwards (fig. 10*c*).

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

I have had great difficulty in assigning its family position to this very remarkable species, and it is with great hesitation that I place it with or next to *Melicerita* in that of the Salicornariadæ. The only other Family to which it might possibly be referred is

that of the Membraniporidæ, against which location, however, there seem to me to be very cogent reasons. In the first place, among the forty or fifty recent and other forms belonging to that Family, there is none, so far as I am aware, in which the cells are disposed in transverse series, nor any in which the surface is divided into angular areas by continuous ridges which apparently belong, as in all the Salicornariadæ, not to the individual zoœcia, but seem to form a continuous network within which the latter are contained. In the Salicornariadæ this continuous network is indicated, as before stated, by slender chitinous continuous hollow threads, and such may be contained within the thick calcified ridges in the present species, or may have been detached with the common epitheca by which they were originally clothed, but which in the single old and worn specimen afforded by the Challenger collection have become lost. Nor among the Membraniporidæ am I aware that any have a central aperture with a beaded and thickened border.

On the other hand, the chief, if not the only obvious, character in which any important divergence from the rest of the Salicornariadæ is exhibited, is the existence of an aperture larger than the true orifice.

All that is wanting to put the question of the Salicornarian affinities of the present species at rest, would be the existence of a chitinous ring or of lateral trabeculæ around or on the sides of the orifice. But whether such a provision existed in the superficial epitheca, or may be still contained in the thickened border of the aperture, I have not been able to make out. A remarkable peculiarity of *Melicerita dubia* is the extremely dense, hard, semi-transparent texture of the zoarium.

Family XV. TUBUCELLARIADÆ.

Cellaridæ (pars), d'Orb.
Salicornariidæ (pars), Macgilliv.
Porinidæ (pars), Hincks.

Character.—Zoarium erect; radicate, composed of cylindrical internodes. Zoœcia disposed round an imaginary axis, convex, distinct, pyriform; peristome produced, tubular. Surface reticulato-punctate or simply punctate with or without a simple median pore on the front (often wanting). Avicularia and oœcia 0.

The Family here contains the following genera:—

1. *Tubucellaria*, d'Orbigny.

(1) *Tubucellaria opuntioides*, Pallas (Pl. XXIV. fig. 7, and Pl. XXXVI. fig. 19).
(2) *Tubucellaria hirsuta*, Lamx. (Pl. XXXVI. fig. 18).

2. *Siphonicytara*, n. gen.

Siphonicytara serrulata, n. sp. (Pl. XV. fig. 2).

1. *Tubucellaria*, d'Orbigny.

Sertularia (pars), Gmelin.
Cellaria (pars), Solander, Lamx., Lamk., Blainv., Reuss, &c.
Cellularia (pars), Pallas.
Tubucellaria, d'Orb., Macgilliv.
Tubicellaria, Heller, Risso, Costa.
Onchopora (sp.), Busk.

Character.—Zoarium composed of cylindrical, usually quadriserial internodes, articulated by flexible tubular peduncles, and arising either dichomotously from the extremity, or irregularly from the sides of the segment from which they spring. Zoœcia pyriform, prolonged, and attenuated downwards, ventricose above and produced into a tubular peristome; bordered by a very thin septal ridge. A simple circular median pore (often absent) in front immediately below the tubular peristome. Surface reticulato-scrobiculate, or simply and sparingly punctate.

The genus *Tubucellaria* was instituted by M. d'Orbigny in 1851–2, for certain forms characterised pretty nearly as above, which had previously been included by himself and others under the vague names of *Cellularia* or *Cellaria*, and for some of which in 1855, not being aware of M. d'Orbigny's definition, I proposed the genus *Onchopora;* which, however, is now restricted to growths of a totally distinct kind. The only modification I have made in d'Orbigny's definition is to make it include more or less regular dichotomous groups; and the existence, at any rate in one division of the genus, of a median frontal pore and a peculiar reticulato-scrobiculate sculpture of the surface.

The genus thus defined would appear to include at least four known and well-marked forms, all of which are characterised by the peculiar sculpture of the surface above noticed, and usually by the presence of a simple circular median pore.

These species are:—

(1) *Tubucellaria opuntioides*, Pallas.
(2) *Tubucellaria cereoides*, Ellis and Solander.
(3) *Tubucellaria hirsuta*, Lamouroux.
(4) *Tubucellaria fusiformis*, d'Orbigny.

And to these it is probable that there may be added a fifth, in which the surface is simply and sparsely punctured and there is no trace of a median pore. To this form I would provisionally attach the name:

(5) *Tubucellaria cæca*, Busk.

Of these species, however, only two occur in the Challenger Collection.

(1) *Tubucellaria opuntioides*, Pallas (Pl. XXIV. fig. 7, and Pl. XXXVI. fig. 19, pars).

Cellularia opuntioides, Pallas, Elench., p. 61, 1766.
Sertularia opuntioides, Gmelin, 1789.
Cellaria cereoides (pars), Lamx., Lamk.
Tubucellaria opuntioides (pars), d'Orb.

Character.—Zoarium 1 to 2 inches high, forming tufted growths (*fruticuli inconditi*, Pallas); ramification irregular, sometimes ternate, rarely opposite; segments short or rather thick. Zoœcia distinct, pyriform, tapering above gradually into the tubular peristome, which curves gently forwards, slightly dilated towards the circular orifice, and grooved longitudinally, each groove containing a series of angular punctures; the intervening ridges finely beaded. Surface (calcined) reticulato-scrobiculate, the bottom of the pits being formed by a delicate centrally perforated calcareous diaphragm; interstitial ridges finely beaded. Operculum (Pl. XXXVI. fig. 19) in the form of a rounded oblong dish-cover, with the convexity outwards and a thickened border or rim. The opening measuring from 0″·006 to ·008 × 0″·003 to ·004.

Habitat.—St. Paul's Rocks, North Atlantic; shallow water.
John Adam's Bank, Voy. of H.M.S. "Herald."]

This well marked form agrees so perfectly with Pallas' admirably graphic description that I have no doubt of its being the species he intended, notwithstanding the difference of locality. Nor can there be any doubt of its distinction from the Mediterranean or may be also North Atlantic form described by Dr. Solander; nor again from a form which I have provisionally regarded as most probably that intended by d'Orbigny under the name "*fusiformis*," of which, if I am right, a fine specimen exists in the British Museum (No. 82, 2, 23, 410), from Thursday Island, Torres Strait, but of which I possess only one or two imperfect fragments from Australia or South Africa, but which suffice to show that the operculum is identical, or nearly so, with that of *Tubucellaria opuntioides*, from which facts we may consider the two to be closely related though differing widely in habit. The operculum also in *Tubucellaria cereoides*, it should be remarked, though of the same peculiar dish-cover-like conformation, is quite distinct.

(2) *Tubucellaria hirsuta*, Lamouroux (Pl. XXXVI. fig. 18).

Cellaria hirsuta, Lamx., Hist. des Polyp., p. 126, pl. ii. fig. 4, 1816.
Cellaria barbata, Lamk.
Cellaria and *Tubucellaria barbata*, d'Orb.
Onchopora hirsuta, Busk.
Tubucellaria hirsuta, Macgillivray, Decade v. p. 52, pl. xlix. fig. 6.

Character.—Zoarium 2 to 3 inches high, composed of tolerably uniform, short, thickish internodes articulated dichotomously. Zoœcia distinct, convex, slender, pyriform, much attenuated downwards, and above gradually tapering into the slender tubular

peristome, which is not grooved, or very obscurely so on the exterior, and not expanded at the orifice; surface reticulato-scrobiculate, the pits with a perforated diaphragm; interstitial ridges thin or even acute, finely beaded. On one or both sides of the front, on a level with the base of the peristome, a long, jointed chitino-calcareous spine articulated by a flexible joint over a circular opening; median pore rather large and often projecting. Operculum not cupped (?) semicircular 0″·007 × ·004–5.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

[New Zealand, Darwin; Colenso; Queenscliff, Portland, Maplestone.]

Incineration shows that the lateral spines in *Tubucellaria hirsuta* are in reality of the nature of ordinary articulated oral spines, though at first sight they resemble radical tubes such as those which project from the front of the zoœcia in *Salicornaria hirsuta*.

2. *Siphonicytara*, n. gen.

Character.—Zoarium continuous, radicate, branched, branches alternate, subcylindrical quadriserial, subsecund. Zoœcia completely immersed below, flattened in front. Peristome tubular, extended. A circular median pore below the middle of the front. A large circular orifice (avicularian ?) near the top of most of the lateral zoœcia behind.

Siphonicytara serrulata, n. sp. (Pl. XV. fig. 2).

The only species.

Habitat.—Station 196, lat. 0° 48′ S., long., 126° 58′ E., 825 fathoms, hard ground.

As the only specimen of this very peculiar form is a small fragment, about 1 inch long, which had been placed by itself in a tube, I have been unwilling to injure it by too minute an examination, so that the internal structure has not been made out quite satisfactorily. I have, however, been able to ascertain one or two interesting particulars.

From the way in which the figures are shaded in the plate, it might be supposed that the lower part of each zoœcium in which the median pore is situated were convex and distinct from the upper part; but this is not really the case. The general surface of the branch, both before and behind, is in reality nearly even, though divided by fine raised lines or vibices, marking the outlines of the zoœcia, and also circumscribing a small area in which the median pore is placed.

The calcareous wall, beneath a strong brownish epitheca, is very thick and solid, and in the oral tube longitudinally fluted, as it is in *Tubucellaria cereoides*.

I have been unable to obtain a distinct view of the operculum, which, however, doubtless exists at the lower part of the tubular peristome.

The median pore, of small size, is circular and papilliform, and surmounted by a chitinous ring as in *Tubucellaria*.

On a transverse section, or rather fracture, of one of the branches the cavities of four zoœcia are exposed, varying of course in size according to the point at which the zoœcium has been broken across. As well as can be seen in such a rude mode of preparation, each zoœcial cavity appears to be divided into an anterior or superficial and a posterior or deeper chamber by a very delicate membranous septum. It would further seem that the posterior and somewhat larger of these chambers is the habitation of the polypide, and that into which the mouth opens, whilst the median pore appears to communicate with the anterior chamber through a very narrow passage. At any rate the dried remains of the polypide, with its vagino-parietal muscles, may be indistinctly discerned in the former; and in the latter, a brownish mass of uncertain nature.

On the dorsal aspect the surface is marked with the same delicate vibices as in front. Close behind the tubular portion of the lateral zoœcia is a large circular opening with a tumid border, and in one or two instances appearing to present a crescentic valvular fold, which may probably represent a modified avicularium; but this is very uncertain.

Towards the lower end of the zoarium, on the dorsal aspect, radical tubes may be seen, entering the backs of the zoœcia at uncertain points (fig. 2*b*). Though a very aberrant form, I do not see where this curious production can be more properly placed than near *Tubucellaria*, with which it appears to have closer affinities than with any other genus. The name is intended to indicate this connection.

Family XVI. Onchoporidæ.

Character.—Zoarium flexible, continuous, branched or lobate, ligulate or foliaceous, then unilaminar; zoœcia urceolate, ventricose. Orifice semicircular, with a straight entire lower lip. On the front, close below the orifice, a lunate fringed pore, and on each side an oblong or circular, perforated disc, with a raised border.

The above characters appear to me to be sufficient to separate the few species included in this small group from the numerous other forms possessing a very similar lunate pore, even when combined with a similarly shaped orifice, as in the genus *Microporella*. But considering, as Mr. Hincks truly remarks, that we do not know the physiological import of the lunate pore, and that the form of the mouth is common to a vast number of species, I am not at present inclined to agree with him in regarding these two characters, even in combination, as alone sufficient to justify the association of such otherwise very dissimilar forms as *Onchopora sinclairii* and *Onchoporella* (*Carbasea*) *bombycina*, Busk, &c., with the lepralian Microporellidæ.

The resemblance, however, between the zoœcial characters in *Onchopora bombycina*

and *Lepralia diadema* of Mr. Macgillivray is very striking, and such as would almost lead to the supposition that the species might be dimorphic. Mr. Macgillivray's species being characterised chiefly by its more highly calcified condition and adnate or decumbent habit, and, what is perhaps of more importance, the existence of several oral spines and of one or two avicularia on the front, appendages never seen in *Onchopora bombycina*.

The Family here contains the following genera:—

1. *Onchopora*, Busk.
   Onchopora sinclairii, Busk (Pl. X. fig. 4).

2. *Onchoporella*, n. gen.
   Onchoporella bombycina (Brit. Mus. Cat.)

1. *Onchopora*.

Onchopora (pars), Bk., Quart. Journ. Micr. Sci., vol. iii. p. 320.
Carbasea (pars), Bk., &c.
Malakosaria, Goldstein, Proc. Roy. Soc. Victoria, June 1881, p. 5, pl. ii. fig. 1.

Character.—Zoarium dichotomously branched, cylindrical, quadriserial.

Onchopora sinclairii, Busk (Pl. X. fig. 4).

Onchopora sinclairii, Bk., Quart. Journ. Micr. Sci., vol. v. p. 172, pl. xv. figs. 1, 2, 3.
Malakosaria pholaramphos, Goldstein, *loc. cit.*

Character.—Zoœcia ventricose, contracted below, usually (but not always) with an obtuse tubercle on each upper angle above the orifice. Lunate pore elongated from side to side, and above it two small round pores. Lateral fenestræ oblong, with two apparent perforations in each. Oœcium globose, prominent, subumbonate, with lines radiating from the centre.

Habitat.—Station 150, lat. 52° 4′ S., long. 71° 22′ E., 150 fathoms, coarse gravel. Station 151, off Heard Island, 75 fathoms, volcanic mud. Station 157, lat. 53° 55′ S., long. 108° 35′ E., 1950 fathoms, Diatom ooze. Station 149D, Royal Sound, Kerguelen, 28 fathoms, volcanic mud.

[New Zealand, Dr. Sinclair; Lyall; Australia, W. H. Harvey; Marion Islands, Voyage of Challenger, Goldstein]

The specimen from Station 157, 1950 fathoms, it should be observed, was in a much injured condition.

2. *Onchoporella*, n. gen.

Carbasea (pars), Gray.
Scruparia (pars), Busk.

Character.—Zoarium foliaceous, unilaminar, ligulate or lobed.

Onchoporella bombycinæ, Busk.

Carbasea bombycina, Bk. (*nec.* Solander, &c.), Brit. Mus. Cat., vol. i. p. 52, pl. xlviii. figs. 4–7.
Flustra bombycina, Linn., Syst. Nat., Ed. 13, 3828, No. 9.
„ „ Bosc, Vers 141; Lamx., Hist. des Polyp., p. 103, No. 196; Exp. Méth. p. 3, pl. iv. fig. B.
„ „ Lamarck (?); Krauss, Zooph. d. Südsee, p. 35.
Semiflustra bombycina (?), d'Orb.
(?) *Lepralia diadema*, Macgilliv.

Character.—Zoarium composed of narrow, ligulate, short lobes, expanding at the ends. Zoœcia pyriform, cylindrical, rounded in front. Lateral fenestræ with from one to four perforations in a vertical line. Oœcia prominent, with radiating lines.

Habitat.—Simon's Bay, Cape of Good Hope.[1]

Family XVII. Reteporidæ.

Reteporidæ, Smitt, 1867; Hincks, 1879.
Escharidæ (pars), d'Orb., 1851; Hincks, 1880; Smitt, 1872; Brit. Mus. Cat., 1852; Busk, Crag Polyz., 1859, Macgilliv., Auctt.

Character.—Zoarium calcareous, erect, fixed; foliaceous and fenestrate, unilaminar; or reticulately or freely ramose in one plane. Zoœcia secund.

The Family here contains the following genera :—

1. *Retepora*, Imperato.

§ *a. reticulatæ.*

(1) *Retepora apiculata*, n. sp. (Pl. XXV. fig. 6).
(2) *Retepora producta*, n. sp. (Pl. XXV. fig. 7).
(3) *Retepora denticulata*, n. sp. (Pl. XXVI. fig. 1).

§ *β. fenestratæ.*

§§ 1.[2]

(4) *Retepora imperati*, Busk, MS. (Pl. XXVI. fig. 9).
(5) *Retepora tessellata*, n. sp. (Pl. XXVII. fig. 8).
var. *a. cæspitosa* (Pl. XXVII. fig. 6).
var. *b. pubens* (Pl. XXVIII. fig. 3).

[1] *Scruparia diaphana*, Busk (*Quart. Journ. Micr. Soc.* [Zoophytology], vol. viii. p. 281, pl. xxxi. fig. 1, 1861) would form a second species of *Onchoporella*.

[2] Under this section might perhaps be included the very interesting *Petralia undata* of Macgillivray as a sub-genus.

§§ 2.

(6) *Retepora gigantea*, n. sp. (Pl. XXVI. fig. 7).
(7) *Retepora lata*, n. sp. (Pl. XXVII. fig. 1).
(8) *Retepora crassa*, n. sp. (Pl. XXVII. fig. 3).
(9) *Retepora atlantica*, n. sp. (?) (Pl. XXVIII. fig. 1).

§§ 3.

(10) *Retepora victoriensis*, n. sp. (?) (Pl. XXVII. fig. 7).
var. (?) *japonica*.
(11) *Retepora simplex*, n. sp. (Pl. XXVIII. fig. 4).
(12) *Retepora hirsuta*, n. sp. (Pl. XXVI. fig. 4).
(13) *Retepora mucronata*, n. sp. (Pl. XXVI. fig. 6).
(14) *Retepora contortuplicata*, n. sp. (Pl. XXVI. fig. 2).
(15) *Retepora cavernosa*, n. sp. (Pl. XXVI. fig. 8).
(16) *Retepora tubulata*, n. sp. (Pl. XXVIII. fig. 2).
(17) *Retepora columnifera*, n. sp. (Pl. XXVI. fig. 5).
(18). *Retepora philippinensis*, n. sp. (Pl. XXVII. fig. 5).
(19) *Retepora phœnicea*, Busk.

§§ 4.

(20) *Retepora delicatula*, n. sp. (Pl. XXVI. fig. 3).
(21) *Retepora margaritacea*, n. sp. (Pl. XXVII. fig. 2).
(22) *Retepora jacksoniensis*, n. sp. (Pl. XXVII. fig. 4).
(23) *Retepora magellensis*, n. sp. (Pl. XXXVI. fig. 20).

2. *Reteporella*, n. sub-gen.

(1) *Reteporella flabellata*, n. sp. (Pl. XXV. fig. 5).
(2) *Reteporella myriozoides*, n. sp. (Pl. XXIV. fig. 2).

3. *Turritigera*, n. gen.

Turritigera stellata, n. sp. (Pl. XXIV. fig. 1).

1. *Retepora*, Imperato.

Retepora (pars), Lamk., Blainv., Johnst., Brit. Mus. Cat., &c.
Eschara (pars), Smitt.
Millepora (pars), Linn., Pallas, Ellis, &c.
Madrepora (sp.), Marsigli.

Character.—Zoarium reticulate, formed of flexuose anastomosing branches; or fenestrate; erect, springing with a calcareous stem, rarely from an incrusting or spreading base. Zoœcia disposed on one aspect only, usually deeply immersed, except on the sides

of the branches or trabeculæ. Primary orifice suborbicular or semicircular; border entire. Afterwards the peristome becomes much raised and multiform, usually fissured in the middle or one side in front, the fissure often becoming a suboral pore by the meeting of the upper angles. Very often a small avicularium on one of the angles which is also frequently developed into a labial or preoral rostrum. Usually numerous adventitious avicularia on one or both aspects of the zoarium.

The known recent species of which any intelligible descriptions have been given, so far as I have been able to ascertain, would appear to be twenty-five or thirty, several of which, however, will probably be found to be merely synonymous, for, as Mr. Hincks remarks, "it is essential that the diagnosis should be much fuller and more minute than authors have usually made it, and identification is not always sure." To which it may be added that up to the present time, one most essential point has been overlooked in all descriptions, viz., the character of the chitinous appendages, which in many cases will be found to afford the easiest and most certain means of diagnosis in this difficult and variable genus.[1] In the following account I have endeavoured to some extent to supply this deficiency, but time has not allowed me to do this so fully as I could have wished.

In his notes on the genus *Retepora*,[2] Mr. Hincks remarks that the notices by the older writers are valueless for purposes of identification, and the same remark applies to many of the descriptions of more modern date.

In the same paper he enumerates as all the recent species described up to that time —

1. *Retepora phœnicea*, Busk, = (?) *Retepora indica*, d'Orbigny.
2. ,, *monilifera*, Macgillivray.
3. ,, *porcellana*, Macgillivray.
4. ,, *granulata*, Macgillivray.
5. ,, *fissa*, Macgillivray.
6. ,, *versipalma*, de Blainville, = (?) *a Hornera*.
7. ,, *marsupiata*, Smitt, = *Retepora cellulosa*, var.
8. ,, *reticulata*, Pourtalès, = (?) *Retepora beaniana*, var.
9. ,, *wallichiana*, Busk and Hincks, = *Retepora elongata*, Smitt.
10. ,, *edwardsii*, = (?) *Retepora cellulosa*.
11. ,, *beaniana*, King.
12. ,, *cellulosa*, Auctt.
13. ,, *couchii*, Hincks.
14. ,, *prætenuis*, Hincks.

[1] Since this was written, Mr. P. H. Macgillivray, in a paper published in the *Proceedings of the Royal Society of Victoria*, August 9, 1883, which has but just come under my notice, has employed this means of diagnosis, and he observes that the chitinous parts are "very characteristic, and in fact it would be possible to identify most of the species by the examination of the *opercula* alone."

[2] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. i. p. 354, 1878.

15. *Retepora plana*, Hincks.
16. ,, *tessellata*, Hincks.
17. ,, *robusta*, Hincks, = (?) *Retepora porcellana*, Macgillivray.

To which may be added—

18. ,, *bi-avicularia*, Smitt, = *Retepora beaniana*, var.
19. ,, *altisulcata*, Ridley.
20. ,, *microthyris*, Busk (MS.).
21. ,, *umbonata*, Macgillivray (var. of *monilifera*).
22. ,, *sinuata*, Macgillivray ,, ,,
23. ,, *lunata*, Macgillivray (?) ,, ,,
24. ,, *acutirostris*, Macgillivray (?) (var. of *monilifera*).
25. ,, *munita*, Hincks (?) ,, ,,
26. ,, *formosa*, Macgillivray.
27. ,, *carinata*, Macgillivray.
28. ,, *serrata*, Macgillivray.
29. ,, *aurantiaca*, Macgillivray.
30. ,, *laxa*, Hincks (? var. *porcellana*, Macgillivray).
31. ,, *avicularis*, Macgillivray.

To this list may be added, from the Challenger Collection, nearly as many more forms, thus raising the known, or approximately known, recent species of *Retepora* to between fifty and sixty. In view of this large number, it becomes almost imperative to subdivide the so-termed genus into sections, each having certain characters in common, and which in a monograph of the genus might perhaps come to be regarded as sub-genera, if such a term has any definite meaning.

With respect to the most convenient mode of arranging the various species, I quite agree with Mr. Hincks in regarding it "as more than doubtful whether the reticulated character of the zoarium is alone sufficient to supply the basis for a generic group." This is in fact abundantly clear from the circumstance that there are not only among the Cheilostomata fenestrate forms, such as *Adeona*, and one or two other Escharidans, but also among the Cyclostomata, as in *Retihornera*. I have therefore not hesitated to include in the same generic group species in which there is either no reticulation of any kind, or one of a different character from that which obtains in the great majority of species. But at the same time a transition, as it may be termed, can be observed from the freely ramified forms to those offering a true reticulation. For, in a certain number of species, the branches or trabeculæ, though lying mainly in one plane, are either quite free or irregularly interlaced, or united either by occasional direct anastomoses, or sometimes by non-celliferous transverse trabeculæ. In the latter case the general disposition of the trabeculæ or branches may be roughly likened to the tracery of Gothic windows of

what is called the "flamboyant" style. Consequently, in the following catalogue I have primarily grouped the species in three artificial, or perhaps natural, divisions or sections, distinguished respectively by their general habit or mode of ramification, though it should be understood that no very definite or abrupt limitation between them can be laid down.

§ *a. reticulatæ.*

Species in which the branches are connected so as to form a reticulate rather than fenestrate growth. Oœcia, when conspicuous, entire in front.

(1) *Retepora apiculata*, n. sp. (Pl. XXV. fig. 6).

Character.—Zoarium of considerable size, irregularly flexuose, much folded, expanding. Meshes extremely irregular in form and size, often traversed by barren trabeculæ. Zoœcia obscurely rhomboidal; primary orifice orbicular, with a wide secondary notch in front. Peristome rising on one side into one or two broad pointed teeth. Anterior avicularia prominent, rostriform, with an erect, acute beak; mandible narrow, lanceolate, acute, horizontal. Oœcia lofty, contracted and hollowed in front, inferiorly with a vertical median keel, and a depression on each side; anterior lip of the opening trifid. Dorsal surface coarsely granular, with a few irregularly dispersed depressed retentive avicularia, with a wide three-pointed mandible.

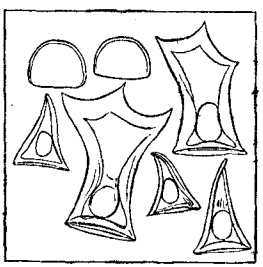


FIG. 16.—*Retepora apiculata.*

Habitat.—Station 172, Nukaʻlofa, Tongatabu, 18 fathoms, coral mud.

(2) *Retepora producta*, n. sp. (Pl. XXV. fig. 7).

Character.—Zoarium rising from a rather broad base; expanding very irregularly in a hypocrateriform fashion, and very flexuose. Meshes elongated, narrow, acute at both ends, and of very irregular size. No barren transverse trabeculæ. Zoœcia urceolate, quite indistinct, orifice of the central ones deeply immersed, orbicular. Peristome level with the surface and unarmed, a rounded papillary eminence, usually on one side of the front. In the lateral zoœcia the peristome very much produced, subtubular, pectinate, each denticle supporting a delicate articulated spine. A very minute labial fissure, one angle of which frequently supports a minute avicularium, with a semi-circular mandible. Oœcia inconspicuous. Anterior avicularia very rare, with a long slender pointed mandible and usually a trifid beak (fig. 7*f*.). Dorsal surface (*c*) divided into irregular

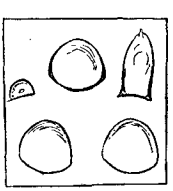


FIG. 17.—*Retepora producta.*

hexagonal areas, most of which present a rounded papillary eminence. Sometimes minute immersed avicularia within the meshes; none on any other part of the surface.

Habitat.—Station 172, Nukalofa, Tongatabu, 18 fathoms, coral mud. Samboangan, 10 fathoms.

[In the woodcut the anterior elongated mandible has been omitted.]

(3) *Retepora denticulata*, n. sp. (Pl. XXVI. fig. 1).

Character.—Zoarium expanded, flexuose, foliaceous, wavy, very irregular in form; composed of bifurcating, anastomosing branches, united very irregularly by transverse barren trabeculæ. Reticulation very unequal, meshes more or less rhomboidal, much elongated and narrow. Zoœcia rhomboidal or fusiform, flattened in front and deeply immersed. Orifice orbicular, notched in front, with a very minute avicularium on one side of the notch. Peristome, more especially in the lateral zoœcia, much produced, subtubular, slightly infundibuliform; usually with two acuminate conical teeth on each side; no spines. Oœcia inconspicuous. A few sparsely scattered large sessile avicularia placed on the front of the zoœcia; mandible spatulate, squarely truncate, pointing obliquely to one side; beak bifid. Dorsal surface finely granular, indistinctly areolated, shining; with deeply immersed avicularia, with blunt spatulate mandible, lodged within the lower angle of some of the fenestræ.

Fig. 18.—*Retepora denticulata.*

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

This species is distinguished from *Retepora producta* by the peristome in that species being much more produced, and its pectination limited usually to one side. In *Retepora denticulata* there are no marginal spines.

The three preceding species, which constitute the whole of the reticulate or flamboyant group, appear to be closely allied, but yet in minute characters they are quite distinct. As will be seen, they all belong to the Pacific regions.

§ *β. fenestratæ.*

Zoaria foliaceous, fenestrate.

§§ 1. Oœcia cucullate, closed, or more or less emarginate in front. Mouth orbicular, anterior border unarmed, simple or sinuate or subcanalicular (not fissured); no suboral pore. Operculum slightly produced below with a strong horse-shoe shaped rim. Dorsal avicularia numerous, usually placed within circumscribed areolæ, or tessellæ.

(4) *Retepora imperati*, Busk, M.S. (Pl. XXVI. fig. 9).

Retepora eschara marina, Imperato, 1559, p. 821.
Retepora cellulosa, α. (pars), Auctt.
Millepora foraminosa, Ell. and Soland., p. 138, pl. xxvi. fig. 2.
(?) *Retepora elongata*, d'Orb. and Smitt, var.

Character.—Zoarium of large size, repand, flexuose, widely infundibuliform. Fenestræ elongate, rhomboidal, narrow, about 0″·085 long. Dorsal surface of trabeculæ smooth and glistening. Zoœcia distinct, ovoid, separated by raised septa; anterior surface granular. Orifice suborbicular, slightly sinuated in front. Peristome thin, much raised on the sides, where it often forms a point. No labial fissure, or suboral pore, or oral avicularium. Oœcia very conspicuous, subcucullate (fig. 9*d*). Anterior avicularia sparse, and placed only on the older zoœcia, rostriform and projecting directly forwards; mandible long, acute, with the point curved forwards. Dorsal avicularia spear-shaped, numerous, irregularly distributed; one usually of larger size than the others at the lower angle of each fenestra. Operculum rounded oval, the muscular insertions on each side above the middle.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ 30″ W., 450 fathoms, volcanic mud. Port Praya, St. Iago, Cape Verde Islands, 100 to 120 fathoms.

[Mediterranean, H.M.S. "Porcupine," M'Andrew].

It is a remarkable circumstance that, so far as I am aware, this very well marked and most conspicuous species should have hitherto, as it would seem, escaped distinct recognition, and the more so as it is probably abundant enough in the Mediterranean, forming, in fact, the bulk of the forms of *Retepora* collected on the voyage of the "Porcupine" in that sea, where, as is well known, three or four other species also occur, all of which have been often confounded under the common appellation of *Retepora cellulosa*.

But reference to the coarse, though sometimes very graphic, figures of the older writers, and especially to that contained in Imperato's work, will suffice to prove that in many, if not most cases, they have had the present form before their eyes.

It has, however, unfortunately happened that most later authors since Ellis have apparently only been acquainted with the two common northern forms, whose general similarity with that figured by Dr. Solander has led to their being confounded with it, although most have recognised a certain difference of habit, leading to the suspicion that the species might be distinct.

In the British Museum Catalogue (1852), the account of the species designated *Retepora cellulosa* was drawn up from specimens in Dr. Johnston's collection, amongst which it so happened that I noticed only the form so named, and another described by Mr. King as *Retepora beaniana*. The former may probably have been intended by Dr. Johnston, under the name of *Retepora reticulata*, but the reten-

tion of such an appellation for a species of a genus nearly all of whose members are in some sense reticulated seemed absurd, and I consequently retained the Linnean appellation. The minute characters assigned to it in the "Catalogue" having to a great extent been adopted by others, it may perhaps be advisable not now to change the appellation, but to retain it for that particular member of the Linnean genus, as has been done by Prof. Smitt. As regards the specific appellation here adopted, and which I have ventured to propose for the large Mediterranean *Retepora*, though Dr. Solander's name "*foraminosa*" might perhaps have been employed, the doing so would have involved a good deal of confusion with other forms, whilst the term itself is objectionable on the same grounds as that of "*reticulata*." In order, therefore, to prevent confusion becoming worse confounded, I have thought it convenient to employ a name which could give rise to no ambiguity, and at the same time include a recognition of the merit of the eminent naturalist who first described the species.

But another consideration also arises with regard to this form, which appears to me to render it doubtful whether, after all, the Mediterranean and Atlantic species here described may not be merely a variety of *Retepora elongata* of d'Orbigny and of Smitt, an arctic form for which at one time I proposed the name of *Retepora wallichiana*. The points of agreement, at any rate, between *Retepora elongata* and *Retepora imperati* are apparently of greater importance than those in which they differ. For instance, they both agree in the absence of fissure or stigma on the front of the œcium, and in the want of any labial fissure or suboral pore, or any avicularian armature about the peristome, which in both though wavy is quite entire and much raised on the sides so as to become canaliculate in the older zoœcia, but is never thickened or fissured. The anterior rostriform avicularia are alike in both, though comparatively larger in the Mediterranean form. Both have the beak hooked like a parrot's and both have a very broad, lanceolate, or subtriangular curved-pointed mandible; and what is of great importance, the operculum in both is of the same peculiar conformation. In most species that I have had an opportunity of examining, the operculum is more or less semicircular or subcrescentic, consisting, in fact, mainly of a semicircular chitinous bow filled in by a thin membrane, the lower border being more or less simply membranous, whilst in *Retepora elongata* and *Retepora imperati*, as in the three succeeding species belonging to the same subsection, it is of a suborbicular or elliptical form, bordered all round, except for a small space at the bottom, by a thick chitinous ring, as shown in the accompanying figures in which (B) represents the operculum of *Retepora elongata* from Spitzbergen, and (A) that

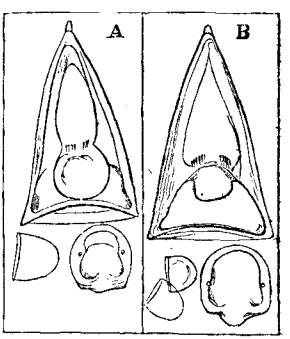


FIG. 19.
A, *R. imperati.*
B, *R. elongata.*

of *Retepora imperati* from the Mediterranean. The points of difference, as will be seen, between them are very slight. The operculum of *Retepora imperati* is smaller and the muscular insertions on the sides of the ring are above the middle, whilst in *Retepora elongata* they are below it. But these differences, trifling as they may seem, appear to be quite constant.

In the general form of the zoarium the aspect of the two differs considerably. The arctic form being altogether much more robust and the fenestræ of larger size and very unequal; in fact, in some instances specimens of *Retepora elongata* might be referred to the flamboyant or reticulate group, whilst in *Retepora imperati* the fenestræ are remarkably uniform in size and shape, and the whole growth is typically fenestrate. Notwithstanding the differences above noticed, and considering the wide interval of space in the habitats of the two forms, which would render variation extremely probable, I am much disposed to consider *Retepora imperati* as a variety of *Retepora elongata*.

(5) *Retepora tessellata* (Pl. XXVII. fig. 8).

Retepora tessellata, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 358, 1878, pl. xix. figs. 9–12; Macgilliv., Proc. Roy. Soc. Viet. 1883.

Character.—Zoarium large, intricately folded and contorted in a very irregular manner. Fenestræ oval or circular, small, tolerably uniform, but occasionally larger in parts of the zoarium. Zoœcia (young) urceolate, convex. Orifice semicircular, widely sinuated or notched (no fissure) in front. Peristome thick, with four large articulated spines (fig. 8*d*), two behind and one on each side. In the older zoœcia the orifice is deeply immersed and the two lateral spines only remain (fig. 8*b*). Surface generally very rugose and studded all over with minute avicularia with an acicular mandible; besides which, sparsely distributed, are large rostriform avicularia, with an acute lanceolate mandible with a very broad base (fig. 8*f*) and pointing downwards. Dorsal surface very rugose, often coarsely pitted and studded with innumerable small acicular avicularia, like those on the front. Oœcia deeply immersed, cucullate.

Habitat.—Simon's Bay, Cape of Good Hope.

The extraordinary way in which this species bristles with minute avicularia on both aspects is a very distinctive character. As only a few small fragments occur in the collection, no certain indication of the general habit of the zoarium is afforded. But a very good specimen exists in the Oxford Natural History Museum.

Var. *a*, *cæspitosa* (Pl. XXVII. fig. 6).

(?) *Retepora tessellata*, Hincks, Macgilliv.

Character.—Zoarium a globose tuft about 1″·5 in diameter, constituted of intricately contorted meandriniform folds; the oval fenestræ as wide as or wider than the trabeculæ; the dorsal surface uneven, no raised vibices, but instead a depressed line marking out distinct areolæ. Zoœcia very indistinct, surface glistening and uneven, or sometimes granular. Orifice orbicular, widely situated in front. Peristome even with the surface. Oœcia conspicuous, transparent, shining, smooth, very slightly depressed in front, without either fissure or stigma. Anterior avicularia rostriform, mandible triangular, acute, or like a shark's tooth, pointing forwards and downwards, or nearly horizontally; dorsal avicularia very irregularly distributed, crowded in some parts and absent in others; mandible triangular, pointed. Operculum horse-shoe shaped.

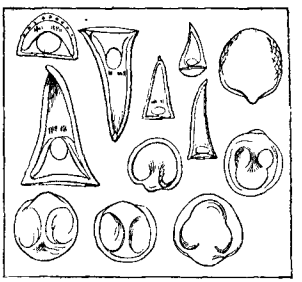


FIG. 20.—*Retepora tessellata* var. *cæspitosa*.

Habitat.—Simon's Bay, Cape of Good Hope.

Var. *b*. *pubens* (Pl. XXVIII. fig. 3).

Character.—Zoarium of very lax habit, composed of compressed branches, which anastomose very irregularly, forming wide irregular meshes, rather than fenestræ, of all sizes and of an elongated rhomboidal form. Zoœcia urceolate, flattened in front and usually presenting a large rostriform avicularium. Mouth orbicular, with a wide sinus in front, and sometimes in the younger cells a little notch on each side. Surface generally finely granular, the granulations having the form of minute cones. Dorsal surface areolated, showing the outlines of the zoœcia, but no raised vibices, and in the centre of each area is a minute immersed avicularium, besides which are numerous prominent small avicularia, with mandibles of the same form as those of the anterior rostriform ones. Oœcia unknown. Operculum horse-shoe shaped.

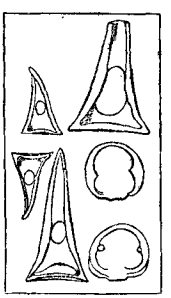


FIG. 21.—*Retepora tessellata* var. *pubens*.

Habitat.—Off Simon's Bay, Cape of Good Hope.

As this peculiar form is represented by only a single small fragment, covered with the acerose spicules of a sponge, which I at first mistook for a natural pubescence, the name was applied accordingly. Though not in the sense originally intended, the name is still to some extent justified by the beautiful granulation of the surface, the character of which is clearly shown in the fragments of the general epitheca

left in decalcified specimens. The great difference between the wide reticulation of this variety and the densely convoluted and minutely fenestrate habit of the variety I have termed "*cæspitosa*," is very remarkable, if the two in reality belong to one species, which there seems little room to doubt. But it is to be remarked that an equally great diversity of habit exists in the arctic *Retepora elongata* or *wallichiana*, some specimens of which are distinctly fenestrate, whilst others are as distinctly reticulato-ramose, whilst in *Retepora imperati*, which, as before observed, may be regarded perhaps merely as a variety of *Retepora elongata*, the mode of growth is always truly fenestrate. I would further remark that there is a form which I should regard also as a variety of *Retepora tessellata*, and of which the only specimen I am acquainted with is in the Oxford Museum, in which the zoarium, besides being bilaminar, is exactly like an *Eschara* (but fissile) throughout, except in a few spots here and there, where it presents the true Reteporine character, whilst the opercula and mandibles are exactly those of *Retepora tessellata* and its varieties. This form, which seems to be as yet undescribed, might be termed *Retepora escharoides*.

§§ 2. Oœcium with a vertical fissure in front.

(6) *Retepora gigantea*, n. sp. (Pl. XXVI. fig. 7).

Character.—Zoarium 2 to 3 inches wide, flabelliform, expanded, springing from a short thick stem. Fenestræ rhomboidal or broadly ovate, about 0″·1 long, and very uniform; trabeculæ nearly cylindrical. Zoœcia elongated, linear, quite immersed except the oral end, which forms a rounded pustulose elevation, in the centre of which is the sunken mouth. Anterior surface uneven, glistening; dorsal coarsely granular, very irregularly areolated, and presenting a few scattered circular pits. Orifice immersed, circular, with a shallow sulcus in front, on one side of which is frequently placed a small avicularium with a semicircular mandible pointing obliquely upwards. In many, more especially of the marginal zoœcia, the peristome rises into a blunt eminence or mucro. Oœcia deeply immersed, with a vertical fissure in front. Anterior avicularia (besides the oral) very rare, and of two kinds, one with an acute curved acuminate mandible pointing obliquely downwards and outwards (fig. 7, *b*.), and more rarely others of small size and oval form with a semicircular mandible (fig. 7, *c*.), and appearing like minute circular pits; in fact they resemble the dorsal pits, which, however, never appear to be furnished with any mandible. Operculum semicircular, 0″·006 × ·0045.

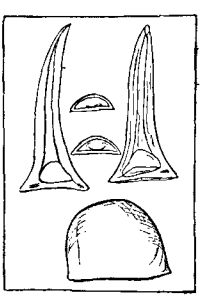


FIG. 22.—*Retepora gigantea.*

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 500 fathoms, hard ground, gravel, shells.

This magnificent *Retepora* is at once distinguished by its gigantic proportions, which appear to be far greater than those of any other known species.

(7) *Retepora lata*, n. sp. (Pl. XXVII. fig. 1).

Character.—Zoarium expanded, folded, large and thick. Fenestræ very small, circular, distant, uniform. Dorsal surface granular, even, without apparent areolation. Zoœcia anterior wall thick, sparsely punctured, granular; in the older zoœcia verrucose. Outline oval or rounded. Mouth orbicular, in the older portions deeply immersed, with a very short labial fissure, soon reduced to a minute pore. Peristome even, very rarely a minute oral spine on one or both sides, more usually none. Oœcia erect, prominent, lofty, immersed at the base, usually with a vertical fissure in front. Anterior avicularia very rare, small, seated on raised papillæ; mandible triangular, pointed. No dorsal or fenestral avicularia.

Habitat.—Simon's Bay, Cape of Good Hope.

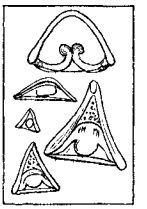


FIG. 23.—*Retepora lata.*

The striking character of this species is the comparatively minute size of the fenestræ in proportion to the width and thickness of the trabeculæ; and in accordance with this the number of zoœcia in the breadth of the branch is very great. Its remarkable operculum should also be noticed.

(8) *Retepora crassa*, n. sp. (Pl. XXVI. fig. 10; Pl. XXVII. fig. 3).

Character.—Zoarium of large size (several inches), irregularly foliaceous, expanded, elongated, rising from a very thick cylindrical peduncle. Fenestræ elongated, much narrower than the wide and thick trabeculæ, about 0″·1 long. Dorsal surface porcellanous, divided into small, irregularly hexagonal areolæ, in the centre of most of which is a prominent papilla, usually supporting a minute avicularium with a semicircular mandible. Zoœcia (young) urceolate, upper half prominent, free, but flattened in front. Orifice orbicular, sinuated. Peristome thin, raised, toothed, expanding, with two long slender unarticulated spines on each side (fig. 3*b*). Labial fissure median, short, wide, with an acute projecting angle on each side; suboral pore small. Oœcia deeply immersed, often open, sometimes closed by a membranous lid, vertically fissured (Pl. XXVI. fig. 10). Anterior avicularia very sparse and only on the older zoœcia, very small with a blunt gouge-shaped mandible, pointing directly downwards.

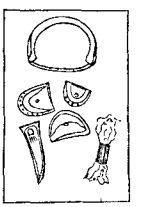


FIG. 24.—*Retepora crassa.*

Habitat.—Station 161, entrance to Port Phillip, 33 fathoms, sand. Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand, shells.

This is a very remarkable form, from its size and peculiar mode of growth. The description of the zoœcia is taken from some at the growing edge, for in the older portions of the zoarium the characters are completely obscured by their crowded growth and deep immersion. The oral spines, though apparently not articulated, are very slender and fragile, and consequently are often wanting. The anterior avicularia are very small and inconspicuous, and may easily be overlooked. A great characteristic is the fine irregularly hexagonal areolation of the dorsal surface, and the existence of the minute umbonal avicularian papilla in nearly all the areolæ. The peculiar formation of the oœcia is also remarkable.

(9) *Retepora atlantica*, n. sp. (?) (Pl. XXVIII. fig. 1).

(?) *Retepora cellulosa*, var. *marsupiata*, Smitt, Florid. Bryoz., pl. xiii. figs. 245–254.

Character.—Zoarium an inch or more in diameter, infundibuliform or irregularly cupped, flexuose, white and pearly. Fenestræ oval, pretty uniform, not quite as wide as the trabeculæ. Zoœcia (young) subcylindrical, free above; surface smooth. Orifice suborbicular. Peristome slightly thickened, often a slender spine on each side towards the front, and sometimes, especially in the lateral zoœcia, rising on one side into three or four obtuse teeth. Labial fissure terminating in a round suboral pore; one angle thickened and prominent, supporting a small avicularium with a semicircular mandible. Oœcia deeply immersed, with a very short vertical fissure with converging sulci or rugæ. Anterior avicularia adventitious on the front of a zoœcium, varying much in size and sloping almost perpendicularly downwards. Mandible membranous, sword-shaped and apiculate. Dorsal surface smooth, vibicate, with elongated areolæ, and beset with numerous avicularia, seated chiefly on the sides of the fenestræ, with an elongated ensiform apiculate membranous mandible.

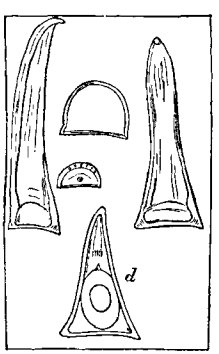


FIG. 25.—*Retepora atlantica.*

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ 30″ W., 450 fathoms, volcanic mud.

[(?) Gulf of Florida, Smitt; Tenerife, W. K. P.; Adriatic, Heller.]

This form so closely corresponds in many respects with Professor Smitt's species, that I am strongly inclined to think they may be the same. The operculum varies somewhat in size and form, and perhaps could scarcely be distinguished from that of *Retepora beaniana* or *Retepora cellulosa*.

But the avicularian mandibles are very peculiar, and sufficient to establish a distinction from those of any other species I have as yet examined. They are all of a very delicate membranous texture, with a small occlusor muscle inserted quite at the base, and having merely a very slight chitinous border at the lower part and no foramen. The avicularia, therefore, would seem to be of the "retentive" rather than the prehensile type, whilst in *Retepora cellulosa*, either from Spitzbergen or the Mediterranean, the avicularia are of the "prehensile" kind, and have the mandible adapted for forcible closure, and furnished with the usual long and powerful occlusor muscles, inserted high up, and with the usual foramen (woodcut 25, *d*). It should be noticed also that in *Retepora cellulosa* the rostriform avicularia stand horizontally out from the surface of the zoœcium, instead of sloping directly downwards as they do in *Retepora atlantica*.

§§ 3. Oœcium with a trifoliate stigma[1] in front.

(10) *Retepora victoriensis*, n. sp. ? (Pl. XXVII. fig. 7).

(?) *Retepora carinata*, Macgilliv.

Character.—Zoarium crateriform or widely infundibuliform. Fenestræ oval, distant, uniform; trabeculæ wide. Zoœcia (young) barrel-shaped or subcylindrical, wide at top; (older) flattened, subrhomboidal, parted by indistinct septal lines; wall smooth, entire, or very minutely and sparsely punctured. Peristome thin, usually raised in front or occasionally widely canalicular, with a short submedian fissure and small pore; one angle of the fissure often thickened and supporting a minute elongated avicularium. A long articulated and jointed spine on one, or sometimes on both, sides of the orifice and occasionally in the young zoœcia one or two slender non-articulated spines on the opposite side. Orifice (primary) in quite young zoœcia arched, with a straight entire lower lip, and sometimes a notch on either side. Oœcia large, prominent, strongly umbonate in front, and beneath the umbo an obscure trifoliate stigma. Anterior avicularia of several kinds; one of large size on low tubercular circular elevations, with a semi-

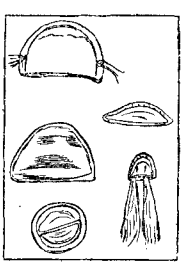


Fig. 26.—*Retepora victoriensis.*

[1] This very peculiar mark on the front of the oœcium, probably indicating the way of exit of the mature embryo, though noticed by Mr. Macgillivray more than twenty years ago, does not appear to have attracted subsequent attention, except in one instance, where Mr. Hincks in redescribing *Retepora monilifera* (1878) adverts to it "as a granulated rim above the upper edge of the aperture, from the centre of which a somewhat clavate band, also granulated or beaded, extends upwards almost to the top of the ovicell." Though forming the foundation of Mr. Macgillivray's name, it will be seen that this mark is by no means confined to that species, but may rather be regarded as more especially characteristic of the Australian *Reteporæ*, amongst which I am not aware that more than one (*Retepora fissa* (?) = *Retepora cellulosa*, Macgillivray) has hitherto been known with a vertical fissure. The Challenger Collection, out of nearly thirty species, affords a second instance (*Retepora crassa*), certainly distinct from Mr. Macgillivray's, whilst the same collection affords at least thirteen furnished with the trifoliate stigma.

circular mandible; another much smaller, boat-shaped; and a third of an oval form and of various dimensions. Dorsal surface granular, shining, vibicate, often with small circular deeply imbedded avicularia.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand.

(?) Var. *japonica.*

Character.—Of much more delicate habit, the walls of the zoœcia being thin, delicate, and transparent. The peristome very thin, and more constantly produced into a wide spout.

Habitat.—Cobie, Japan, 8 to 50 fathoms.

[North Japan, Captain St. John.]

Notwithstanding a considerable difference in habit, as these two forms agree in many essential particulars, I have with some hesitation provisionally regarded them merely as varieties. The Japanese form is much more delicate in all respects, and the anterior avicularia, though of the same form as in the other and distributed in the same manner, are much smaller. The oœcia also appear much more numerous, and they present the peculiarity of remaining entirely open in front, apparently for a long time, as very few if any can be seen closed in. One character of the species which may facilitate its diagnosis is the great number of zoœcia in the width of the trabeculæ, and the frequently very regular way in which they are disposed in oblique, transverse rows. The operculum also in *Retepora victoriensis* is thick, and in var. *japonica* very delicate.

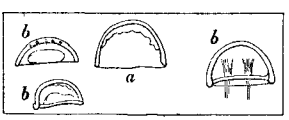


FIG. 27.—*Retepora victoriensis* var. *japonica.*

(11) *Retepora simplex,* n. sp. (Pl. XXVIII. fig. 4).

Character.—Zoarium about 1″·25 high, irregularly infundibuliform, rising from a broad base; fenestræ oval, usually with a projection on one side, about 0″·025 × ·015 and of about the same width as the trabeculæ. Dorsal surface finely granular, no distinct vibices. Zoœcia convex, broad and short, ovate, surface subrugose. Orifice orbicular, peristome thin, deficient posteriorly. Labial fissure nearly median, very short and terminating in a rather large pore. A minute labial avicularium with semicircular mandible (often absent) on one of the angles of the fissure. A few scattered prehensile avicularia (readily overlooked) on the front and a few elongated retentive ones behind or in the fenestræ. Oœcia lofty, with a trifoliate stigma (fig. 4*b*), often widely open.

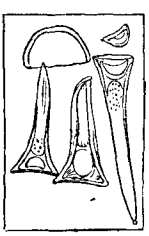


FIG. 28.—*Retepora simplex.*

Habitat.—Samboangan, 10 fathoms. Admiralty Islands.

This form appears to be closely allied to *Retepora contortuplicata* and *Retepora cavernosa*.

(12) *Retepora hirsuta*, n. sp. (Pl. XXVI. fig. 4).

(?) *Retepora monilifera*, Macgilliv., Hincks.

Character.—Zoarium of large size, irregularly folded or crateriform, without any distinct peduncle. Fenestræ small, oval, uniform, and fringed, as it were, with the oral spines or cilia. Zoœcia in the older portions quite immersed; when young subcylindrical, with a glistening surface. Orifice suborbicular or triangular, with rounded angles. Peristome raised in front and on the sides; a short sublateral labial fissure, which is merged more or less completely into a very large round suboral pore nearly as large as the orifice. Usually five long clavate antenniform oral spines (often absent), except in the marginal zoœcia. Oœcia conspicuous, with a trifoliate stigma. Anterior avicularia with a long delicate acuminate mandible (fig. 4*d*.) pointing transversely, and a bifid beak. Similar dorsal or rather fenestral avicularia. Besides these, on every lateral zoœcium, a minute conical avicularium (fig. 4*c*.) which projects into the fenestra, and has a bifid beak and a sharp pointed retentive mandible. Dorsal surface smooth and polished, indistinctly areolated.

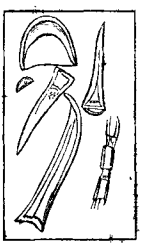


FIG. 29.—*Retepora hirsuta.*

Habitat.—Station 186, off Cape York, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

Mr. Hincks (Ann. Nat. Hist. May 1878, p. 360, Pl. XIX. figs. 1–5), in describing Mr. Macgillivray's *Retepora monilifera*, remarks upon the great diversities in the habit of growth, and the remarkable variety of avicularian appendages which it exhibits. And Mr. Macgillivray (Proc. Roy. Soc. Vict., part. v. p. 4), notices several forms which he regards as varieties; and in my own collection I have several specimens doubtfully referrible to apparently the same generic type. In the Challenger Collection the only one referrible to this type is that above named, but to which, if any, of Mr. Hincks' or Macgillivray's supposed varieties I am quite unable to determine from the published descriptions or figures. To judge from Mr. Macgillivray's figures of the chitinous parts, it is, however, pretty certain that *Retepora hirsuta* does not represent either his typical *Retepora monilifera* nor any of its varieties as there depicted. Nor in the absence of the evidence afforded by those parts can it be determined whether it is the *Retepora monilifera* of Mr. Hincks or either of the varieties he alludes to. The trifoliate fissure on the oœcium and the moniliform or antenniform oral spines are common to several other quite distinct forms. So far as my observation extends I believe,

however, that the peculiar conformation of the operculum, and other chitinous parts, will be found characteristic in what might be termed the whole moniliferous group.

(13) *Retepora mucronata*, n. sp. (Pl. XXVI. fig. 6).

Character.—Zoarium probably much folded and irregularly contorted. Fenestræ broad, oval, about 0″·02 long, tolerably uniform. Zoœcia subrhomboidal in outline, completely immersed; anterior wall very thick, smooth and porcellanous; dorsal surface finely granular, with very distinct vibices and numerous small scattered immersed avicularia. Orifice orbicular. Peristome not raised, thickish, with a very minute labial sublateral fissure and pore; the lower or anterior lip on one side, often projecting into a pyramidal mucro or spout (fig. 6*c*). Oœcia subimmersed, depressed, with a small pore near the summit in front of a large trifoliate perforated stigma (fig. 6*d*). Anterior avicularia very rare, with a long spear-shaped mandible (fig. 6*e*), or sometimes with a blunt nearly semicircular one, like those on the dorsal surface.

Habitat.—Station 208, lat. 11° 37′ N., long. 123° 31′ E., 18 fathoms, blue mud.

A striking characteristic of this species is the peculiar translucent, thick, porcellanous nature of the zoœcial wall, and the production of the peristome in the older cells into a strong short mucro (in the younger it more usually assumes the form of a short spout), and the very minute labial fissure and pore, which in fact are only visible in the youngest zoœcia.

It is represented in the collection only by two or three small dead fragments, so that the general habit and chitinous parts cannot be determined.

(14) *Retepora contortuplicata*, n. sp. (Pl. XXVI. fig. 2).

Character.—Zoarium foliaceous, much and intricately folded, the folds frequently anastomosing (fig. 2*a*). Fenestræ oval, elongated, about 0″·02 long, very uniform. Zoœcia wholly immersed, those in the middle of the branches flattened or concave in front. Surface smooth, entire, bordered by an acute raised septal line. Dorsal surface smooth, with well-marked but thin vibices. Orifice orbicular. Peristome rather thick, with a sublateral fissure, shortly terminating in a suboral pore; a single oral spine on either side. Oœcia small, conical, acuminate, with a narrow trifoliate stigma. Anterior avicularia rare, placed on a small tubercular elevation, rather to one side of the front, close to the suboral pore. Mandible triangular,

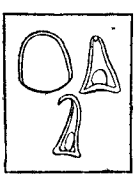


FIG. 30.—*Retepora contortuplicata.*

sometimes more acuminate and curved, pointing obliquely upwards and outwards (fig. 2b). No dorsal avicularia.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

The specimens of this well-marked species in the Challenger Collection are very numerous, but unfortunately only in fragments of various sizes, some of which measure 2 to 3 inches across. The specimen figured, of the natural size, is one that has been long in my collection. Mr. Hincks appears to have contemplated giving the same name to a variety of *Retepora monilifera*.[1]

(15) *Retepora cavernosa*, n. sp. (Pl. XXVI. fig. 8).

Character.—Zoarium intricately contorted, the folds forming numerous anastomoses, so as to constitute a collection of tubular cavities about 0″·25 in diameter. Fenestræ very minute, circular or suboval, uniform. Zoœcia with very thick walls, deeply immersed and irregularly disposed. Orifice immersed, with a thick tumid peristome. Labial fissure nearly median, very short, forming, in fact, merely a small labial pore, the peristome being thickened on each side of it. Outline of zoœcia very obscure, but apparently rhomboidal. Oœcia tumid, convex in front, with a wide, trifoliate, perforated stigma; the anterior border of its orifice straight (fig. 8*d*). Anterior avicularia very rare, of an oval form, slightly elevated; mandible short, spear-shaped, acute, pointing obliquely downwards. No dorsal or fenestral avicularia.

Fig. 31.—*Retepora cavernosa.*

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 500 fathoms, hard ground, gravel, shells.

As this form is represented in the collection by only one or two fragmentary specimens, the habit and dimensions of the zoarium cannot be determined, but it is probable that the latter are considerable. In its intricately contorted growth *Retepora cavernosa* resembles *Retepora columnifera*, but in that species the alveoli formed by the anastomoses of the folds are for the most part infundibuliform, whilst in *Retepora cavernosa* they may be more correctly described as tubular.

(16) *Retepora tubulata*, n. sp. (Pl. XXVIII. fig. 2).

Character.—Zoarium springing from a narrow base, without a distinct peduncle; immediately becoming tubular and continuing to grow by throwing out short tubular alveoli, each of which soon expands into a wide infundibuliform dilatation. Fenestræ

[1] Ann. Nat. Hist., ser. 5, vol. i. p. 362, 1878.

oval, narrower than the trabeculæ. Zoœcia ovate or subrhomboidal, flattened in front; very distinct in the younger portions and separated by a thin septal ridge; walls very thin and transparent, surface smooth. Orifice suborbicular. Peristome thin and usually produced on the sides and in front into a spout-like projection, sinuated in the middle. Labial fissure small and apparent only in some zoœcia, being usually merged in the wide canalicular sinus. An angular ridge descends from the projecting lip and is lost on the flattened anterior surface of the zoœcium. A small avicularium, seated on a low eminence, is sometimes seen a little below and to one side of the orifice, with an obtuse, or sometimes acute, triangular mandible pointing laterally or in front. Dorsal avicularia small and sparse, resembling the anterior or semicircular ones. In some of the fenestræ are boat-shaped, retentive avicularia, with a double bifid beak, and furcate membranous mandible, very like those in *Retepora columnifera*. Oœcia of large size, subglobose, with a trifoliate stigma, the upper limb of which usually terminates in an acuminate tubercular point.

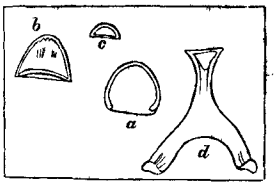


FIG. 32.—*Retepora tubulata.*

Habitat.—Station 186, off Cape York, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

Differs from *Retepora philippinensis* (in which species the zoarium is also constituted of more or less tubular or trumpet-shaped, but much wider, alveoli) in having the celliferous surface, as usual, on the internal face of the alveoli. And besides this, *Retepora philippinensis* seems in all probability to be completely unarmed.

(17) *Retepora columnifera*, n. sp. (Pl. XXVI. fig. 5).

Character.—Zoarium 1 inch to 2 inches or more in height, composed of numerous, widely expanding, flexuose, infundibuliform alveoli; spreading over and affixed to foreign bodies, not by a common peduncular base, but by numerous solid or tubular calcareous columnar processes springing from the dorsal surface. Fenestræ oval, about the same width as the trabeculæ, and of very uniform size. Zoœcia two or three in the width of a trabecula, immersed and flattened in front; surface entire, smooth. Orifice orbicular, with a small shallow fissural notch in front, which in the youngest zoœcia sometimes presents a very minute avicularian tubercle on one angle. Generally, however, the peristome is thin, slightly

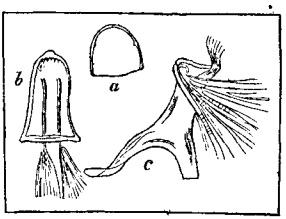


FIG. 33.—*Retepora columnifera.*
a, Operculum; *b*, Columnar avicularium; *c*, Fenestral avicularium.

raised and prominent in front. Oœcia rather large, globose, with a trifoliate stigma. Anterior adventitious avicularia very sparse, in the form of cylindrical, slightly curved, obliquely truncated columns, which spring from the front of a cell (fig. 5*c*), and have a blunt duck-bill shaped mandible. At the lower angle of many of the fenestræ retentive avicularia occur, in the form of a boat with a double prow (fig. 5*e*), each of the prows having a bifid beak, and each branch of the furcate, membranous mandible fits into one of the bifid beaks, the space between the branches of the fork being partially filled with a delicate membrane (fig. 5*d*).

Dorsal surface shining, finely granular or submuricate, with distant indistinct vibices, and a few immersed avicularia of the same conformation as the fenestral, but of very much smaller size.

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 49 fathoms, green mud.

This species, which has several characters in common with *Retepora tubulata*, is, however, at once distinguished by its peculiar mode of attachment by means of solid columnar dorsal processes, which are doubtless homologous with the chitinous tubular processes, by which several *escharan* species of *Membranipora* and *Diachoris* are attached. The anterior columnar avicularia also form a conspicuous feature, altogether wanting in *Retepora tubulata*. These may, perhaps, be regarded as homologous with the columnar dorsal processes.

(18) *Retepora philippinensis*, n. sp. (Pl. XXVII. fig. 5).

Character.—Zoarium (in a single specimen) about 1 inch long, infundibuliform, with the sides pinched in. Fenestræ very small, circular, and very uniform in size. Celliferous surface external, dorsal (or non-celliferous) surface interior, smooth, dull. Zoœcia urceolate, distinct. Orifice orbicular. Peristome thick, deficient or slightly tuberculated behind, slightly raised in front and on the sides; sometimes subcanaliculate in front. Labial fissure, or rather sinus, rather wide and shallow. Oœcia conspicuous, acuminate in front, with a row of three or four punctures close to the border of the orifice (fig. 5*b*). Avicularia 0 (?)

Habitat.—Station 212, lat. 6° 54′ N., long. 122° 18′ E., 10 to 20 fathoms, sand.

As the only specimen is a small dead and imperfect fragment, the general habit and size of the zoarium and the characters of the chitinous parts cannot be stated, but it probably consists of a congeries of infundibuliform or trumpet-shaped alveoli. One peculiarity consists in the circumstance that, contrary to the usual arrangement, the celliferous surface is on the outside of the folds; and another peculiarity is the apparently complete absence of avicularia of any kind.

(19) *Retepora phœnicea*, Busk.

Retepora phœnicea, Bk., Brit. Mus. Cat., vol. i. p. 94, pl. cxxi. figs. 1, 2.

Character.—Zoarium folded, expanding, much convoluted; of a purple colour. Zoœcia ovate, ventricose. Orifice prominent, circular, sometimes subtubular. Border entire or irregularly serrate. Raised interzoœcial septal ridges. Anterior avicularia sparse, placed obliquely on the front, close below the orifice, with an acuminate mandible very wide at the base. Oœcia immersed (when young having in front a concentrically marked operculum).

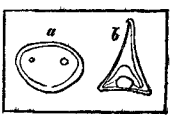


FIG. 34.—*Retepora phœnicea.*

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand, shells.

[South Australia, Adelaide, Glenelg, Hincks.]

I have placed *Retepora phœnicea* with the species furnished with a trifoliate stigma, considering that the stigma is represented by the sort of operculum with which its oœcium is at one time furnished, and which is probably of the same nature as the stigma.

§§ 4. Oœcia inconspicuous or unknown.

(20) *Retepora delicatula*, n. sp. (Pl. XXVI. fig. 3).

Character.—Zoarium about 0″·5 high, cup-shaped, springing from a central point, but without any actual peduncle. Fenestræ oval, uniform. Zoœcia broadly ovate. Orifice wide, orbicular. Peristome raised and canaliculate in front, expanding on the sides. Anterior lip with a lateral fissure, terminating in a large rounded pore. On one side of the fissure an extremely minute avicularium, on a small tubercular thickening of the angle. From 1 to 3 oral spines, sometimes obscurely jointed on each side. Oœcia inconspicuous. Anterior avicularia extremely rare; seated on short conical processes. Mandible triangular, obtuse, pointing forwards; dorsal or rather fenestral avicularia deeply immersed; the mandible, which is deeply sunk, is long, slender, and usually furcate, pointing directly downwards.

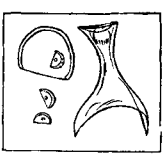


FIG. 35.—*Retepora delicatula.*

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 45 fathoms, green mud.

The furcate fenestral avicularian mandible is something like that of *Retepora tubulata* and *Retepora columnifera*, but the limbs of the fork are wider, shorter, and pointed instead of being obliquely truncated. A special group might perhaps be made of the species having furcate retentive mandibles. There are several besides those in the Challenger Collection, and all probably Australian or New Zealand forms.

(21) *Retepora margaritacea*, n. sp. (Pl. XXVII. fig. 2).

Character.—Zoarium foliaceous, expanded. Fenestræ elliptical, irregular in size and form, about the same width as the trabeculæ. Dorsal surface finely verrucose, glistening, pearly. Zoœcia deeply immersed, outline imperceptible, surface warty. Orifice deeply immersed, elliptical from side to side; labial fissure sublateral, short and wide. Peristome slightly raised all round, posteriorly pectinate, with four or five obtuse teeth, upon which are articulated short slender pointed spines. Oœcia inconspicuous. Anterior avicularia in front of almost every zoœcium, on one side close below the labial fissure or pore; large and prominent, with a much curved slender acute mandible pointing horizontally to one side (fig. 2*a*); the edge of the avicularian cup serrated. Besides these, when the larger ones are absent, a minute avicularium on one side close below the suboral pore (fig. 2*b*). No dorsal avicularia.

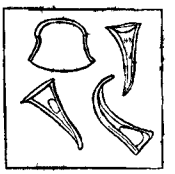


FIG. 36.—*Retepora margaritacea.*

Habitat.—Station 176, lat. 18° 30′ S., long. 173° 52′ E., 1450 fathoms, Globigerina ooze.

Unfortunately only a single specimen of this interesting form was contained in the gathering at this Station. The width of the specimen is about 0″·75. It is convex on the anterior side, and to the naked eye is chiefly remarkable for the irregular size and disposition of the fenestræ. The verrucose, beautifully pearly, glistening surface is also distinctive, as well as the size and position of the anterior avicularia, and the form of the mandible, which is remarkable for its long curvature.

(22) *Retepora jacksoniensis*, n. sp. (Pl. XXVII. fig. 4).

Character.—Zoarium infundibuliform, flexuose. Fenestræ oval, narrow, pointed at each end, irregular in size. Zoœcia elongated, rhomboidal, flattened in front. Peristome much raised on the sides and the front, bifid or trifid on each side. Labial fissure wide and shallow, anterior surface smooth, with a strongly raised septal line. Dorsal surface wrinkled, with irregular wavy vibices. Oœcia inconspicuous. Anterior avicularia sparse, placed rather to one side of the upper part of the front; in the younger zoœcia almost level with the surface, mandible acute, pointing directly downwards; in the older zoœcia the avicularium forms a prominent central rostrum (fig. 4*b*), in which the mandible of the same shape, and not much larger, points directly forwards. No dorsal avicularia, but occasionally one like the anterior at the lower angle of a fenestra.

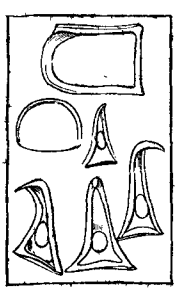


FIG. 37.—*Retepora jacksoniensis.*

Habitat.—Port Jackson, 2 to 10 fathoms, mud.

Among the chitinous parts in this species I have occasionally noticed one of the peculiar form shown at the top of the figure—the nature of which is obscure.

(23.) *Retepora magellensis*, n. sp. (Pl. XXXVI. fig. 20).

Character.—Zoarium infundibuliform or cupped, rising from a short thick peduncle. Fenestræ elongate oval, pointed at each end about 0″·1 × ·05, rather narrower than the trabeculæ. Surface both before and behind finely granular and glistening. No dorsal or fenestral avicularia and no vibices. Zoœcia elongate, ovate, convex, and distinct in the younger parts. Orifice contracted, primarily clithridiate, peristome, not thickened, with a short submedian fissure and small pore, and a labial avicularium on one angle; four to six slender oral spines visible only in the youngest cells. Operculum semicircular, with a thick rim, about 0″·012 × ·01, and often having two lemniscus-like sacculi dependent behind the lower border. Avicularian mandible, with very strong occlusor muscles, and an elongated lemniscus-like sacculus between them.

Habitat.—Station 320, 37° 17′ S., 53° 52′ W., 600 fathoms, green sand.

[Falkland Islands, Miss Gatty].

2. *Reteporella*, n. sub-gen.

Character.—Those of *Retepora*, but the branches free in one plane.

(1) *Reteporella flabellata*, n. sp. (Pl. XXV. fig. 5).

Character.—Zoarium flabellate, about 1″·5 high, and wide; composed of dichotomous branches, diverging from a thick common peduncle, attached to coral by a calcareous non-celliferous expansion. Zoœcia (young) ovate, convex; surface granular, glistening, pearly. Orifice orbicular. Peristome thick, annular, slightly raised; a rather long labial fissure terminating in a large pore. From one to three broad, flattened, lanceolate, antenniform, articulated spines on one or both sides. Anterior avicularia on tubercular eminences, seated on the lower part of most of the zoœcia; mandibles, very delicate, membranous. No dorsal avicularia. Dorsal surface, showing the outlines of the zoœcia, pearly, granular, not vibicate. Oœcia 0 (?)

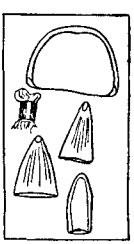


Fig. 38.—*Reteporella flabellata.*

Habitat.—Station 151, off Heard Island, 75 fathoms, volcanic mud.

Only a single specimen of this interesting form occurs in the collection. In the lower parts of the zoarium the surface is almost smooth and entire, nearly all traces of the individual zoœcia being completely obliterated.

(2) *Reteporella myriozoides*, n. sp. (Pl. XXIV. fig. 2).

Character.—Zoarium irregularly branched, for the most part in one plane; branches mostly opposite and forked at the ends (fig. 2*a*). Zoœcia (young) ovate, deeply immersed; surface closely pitted or punctate, puncta elongated. Orifice (primary), orbicular, with a wide sublateral fissure, and usually very deeply immersed. Secondary orifice orbicular, with a very thick annular peristome, usually mucronate, rather to one side in front; sometimes a small avicularium on the inner base of the mucro. Anterior avicularia rare, on very slight eminences on the front of a zoœcium; mandible obtuse, pointing downwards (fig. 2*c*). Dorsal surface pitted, without avicularia. Oœcia (?)

Habitat.—Station 148, lat. 46° 47′-53′ S., long. 51° 37′-52′ E., 210 to 500 fathoms, hard ground, gravel, shells.

This extremely aberrant form is very doubtfully referred to the Reteporidæ. In some respects it appears to resemble a *Myriozoum*, but the peculiar fissured orifice has induced me to place it with or near the former group.

Geographical Range of Retepora.

Two species occurred in the North Atlantic region—

Retepora imperati.
„ *atlantica.*

Five in the South Atlantic region—

Retepora tessellata.
var. *cæspitosa.*
var. *pubens.*
„ *lata.*
„ *magellensis.*

Four in the South Indian region—

Retepora gigantea.
„ *cavernosa.*
Reteporella flabellata.
„ *myriozoides.*

Eleven in the Australian region—

Retepora apiculata.
„ *producta.*
„ *crassa.*
„ *victoriensis.*
„ *hirsuta.*
„ *tubulata.*
„ *columnifera.*
„ *phœnicea.*
„ *delicatula.*
„ *margaritacea.*
„ *jacksoniensis.*

Five in the Philippine region—

Retepora producta.
„ *japonica.*
„ *simplex.*
„ *mucronata.*
„ *philippinensis.*

Two in the North Pacific region—

Retepora denticulata.
„ *contortuplicata.*

Bathymetrical Range.

As at many of the Stations the depth varies very considerably, and in some is not stated at all, it is impossible for most of the species to specify any definite depth. It would seem, however, that of the twenty-six species six must have lived at a less depth than 20 fathoms, viz :—

Retepora simplex.
„ *hirsuta.*
„ *mucronata.*
„ *tubulata.*
„ *philippinensis.*
„ *jacksoniensis.*

Six under 50 fathoms—

Retepora denticulata.
,, *victoriensis.*
var. *japonica*
,, *contortuplicata.*
,, *columnifera.*
,, *delicatula.*

Ten under 240 fathoms—

Retepora apiculata.
,, *producta.*
,, *crassa.*
,, *phœnicea.*
,, *tessellata.*
var. *cæspitosa.*
var. *pubens.*
,, *gigantea.*
,, *lata.*
Reteporella flabellata.

Five under 600 fathoms—

Retepora imperati.
,, *atlantica.*
,, *cavernosa.*
,, *magellensis.*
Reteporella myriozoides.

One at 1450 fathoms—

Retepora margaritacea.

On the whole, therefore, the Family, as represented in the Challenger Collection, would seem to belong for the most part to comparatively shallow depths, and the nature of the bottom appears to have been indifferent; in most cases it was mud of various origin (continental, coral or volcanic), in a few instances sand or gravel, and in one Globigerina ooze.

3. *Turritigera*, n. gen.

Character.—Zoarium ramose, arising from a calcareous expansion, encrusting foreign bodies, having the openings of the zoœcia usually on one side only. Zoœcia ventricose or flask-shaped, much produced and subtubular above, with several conical or columnar avicularian processes on the peristome.

Turritigera stellata, n. sp. (Pl. XXIV. fig. 1).

Character.—Zoarium composed of four or five short furcate branches, springing from a common peduncular centre, and forming a stelliform growth. A few scattered anterior avicularia (with a duck-bill shaped mandible pointing downwards). Dorsal surface finely rugose, studded with numerous minute papilliform eminences, supporting small avicularia.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand. Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand.

This very remarkable form appears to be more nearly allied to *Retepora* than to any other generic group, but the very curious conformation of the oral portion and aperture, and its other peculiarities, seem to justify its being considered as generically distinct.

The inflated, ventricose, or flask-shaped zoœcia, rise into a long and usually free tubular process, around whose opening spring several cylindrical columnar processes (fig. 1*b*), each supporting on its summit a small avicularium. But besides the columnar processes, there is always a larger one on the posterior side; of a conical form, and having its avicularium below the summit. The number of these avicularian processes increases with the age of the zoœcium. The first to make its appearance is the hinder conical one, then appears one on each side of a cylindrical form, then a third or fourth in front. The armature of the peristome, therefore, and especially the posterior conical process, is very similar to that of many Cellepores; and in the same connection it may be remarked that here and there may be noticed an adventitious zoœcium of smaller size, but otherwise of the same conformation as the others springing from the front of one of the older zoœcia.

Although, generally speaking, the zoarium shows the oral orifices only on one face, occasionally an opening may be seen on the dorsal aspect. In one instance of this kind the elongated stem of a young Comatula, or Crinoid of some kind, may be seen issuing from the orifice (fig. 1*d*).

Family XVIII. Cribrilinidæ, Hincks.

Cribrilinidæ, Hincks, Brit. Mar., Polyz., vol. i. p. 182.
Escharidæ (pars), Johnst., &c.
Membraniporidæ (pars), Busk.
Eschariporidæ (pars), Smitt.
Escharellidæ, &c., d'Orb.

Character.—Zoarium crustaceous, or adnate (lepralian), or erect and unilaminar (hemescharan). Zoœcia, front with transverse or radiating fissures or rows of punctures without fissures. Mouth simple, suborbicular, sometimes mucronate or semicircular; with or without a median suboral pore.

Cribrilina, Gray.

α. Front fissured.

§§ 1. *lepralian.*

(1) *Cribrilina radiata*, Moll.

(2) *Cribrilina latimarginata*, n. sp. (Pl. XXII. fig. 10).

§§ 2. *hemescharan.*

(3) *Cribrilina philomela*, n. sp. (Pl. XVII. fig. 6).
var. *α, adnata*, nov. (Pl. XXII. fig. 7).

§ β. Front, with punctures in more or less transverse rows.

(4) *Cribrilina labiosa*, Busk, var. *α, fragilis* (Pl. XIX. fig. 4).

(5) *Cribrilina monoceros*, Busk (Pl. XIX. fig. 8).

1. *Cribrilina*, Gray.

Cribrilina, Gray, Hincks, Smitt.
Cellepora (pars), Fabricius.
Eschara (pars), Moll.
Lepralia (pars), Brit. Mus. Cat., Johnst.
Reptescharella, d'Orb.
Escharipora, Smitt.

Character.—Front of cells fissured, or simply punctured in regular or irregular transverse rows.

§ α. Front fissured.

§§ 1. *Adnate* (*lepralian*).

(1) *Cribrilina radiata*, Moll.

Eschara radiata, Moll, Seerinde, p. 63, pl. iv. fig. 17.
Cribrilina radiata, Smitt, Florid. Bryoz., pt. 2, p. 22, pl. v. 107–108; Hincks, Brit. Mar. Polyz., vol. i. p. 185, pl. xxv. figs. 3, 4.
Lepralia radiata, Bk., Quart. Journ. Micr. Sci. vi., pp. 128, 263, pl. xx. fig. 4.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud. Station 135A, off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel.

For further synonymy, more especially of fossil forms, reference may be made to Mr. Hincks' account of the species. It appears to be widely distributed throughout the North Atlantic zone and in the Mediterranean.

(2) *Cribrilina latimarginata*, n. sp. (Pl. XXII. fig. 10).

Character.—Zoœcia oval, completely immersed, the front surrounded by wide, thick, flattened borders or bands on each side, which arch over the orifice and meet,

leaving a fissure between their rounded and expanded ends. Orifice semicircular or subcrescentic, with a straight entire lower lip; peristome very slightly thickened, entire, even. The front of the zoœcia within the border formed of eight transverse, confluent costæ; the intercostal sulci with several minute pores and a large one at the outer end. No mesial line or fissure. Below the apex of each zoœcium is a large suborbicular opening, probably avicularian or vibracular. Oœcia inapparent.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms, hard ground (on dead coral).

Reuss (Paläontologische Studien über die älteren Tertiärschichten der Alpen, p. 80, Pl. XXX. fig. 9), describes and figures under the name *Celleporaria radiata* a form, in some respects closely resembling *Cribrilina latimarginata* so far as the zoœcia are concerned. The sculpture of the front appears to be precisely the same, and there is also a large opening below each zoœcium. The differences, however, in other respects appear to be too great to allow of the supposition that the species are identical. According to Reuss, *Celleporaria radiata* consists of ascending irregularly branched stems, composed of concentric layers of cells; and the interzoœcial spaces, instead of being occupied by a broad solid band, present a series of very irregular, angular, unequal pores or cancelli, which sometimes attain a considerable size.

§§ 2. *Free; erect or decumbent (hemescharan).*

(3) *Cribrilina philomela*, n. sp. (Pl. XVII. fig. 6).

(?) *Cribrilina speciosa*, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 8, pl. i. fig. 8, 1881.
(?) *Reptescharella inæqualis*, d'Orbigny, Palæont. Franç., p. 467, pl. 716, figs. 1-3.

Character.—Habit hemescharan; zoœcia oval, separated by deep sulci. Front rather flattened, with 7 to 8 shallow transverse fissures on each side, finely perforated; no suboral pore. Mouth large, semicircular or slightly coarctate, with a straight entire lower lip. Peristome thin and sharp. Occasionally minute erect tubuli occur in the interzoœcial sulci. Oœcia lofty, prominent, globose, slightly keeled in front, with a pyriform or crescentic stigma on each side; posterior wall of zoœcia entire, convex, very delicate.

Habitat.—Off Marion Island, 50 to 75 fathoms.

Var. *a. adnata* (Pl. XXII. fig. 7).

(?) *Cribrilina figularis*, var.

Character.—Closely adnate (lepralian). Occasionally a large spatulate vicarious avicularium. Zoœcia distant.

Habitat.—Off Marion Island, 50 to 75 fathoms (on a species of *Myriapora*). Station 151, Heard Island, 75 fathoms.

[? Curtis Island, Hincks].

As remarked by Mr. Hincks, with respect to his *Cribrilina speciosa*, with which I am strongly inclined to think the present form may be identical, it is closely allied to if not merely a variety of *Cribrilina figularis*, from which nevertheless it presents such considerable differences as to entitle it in my opinion to be regarded as distinct.

1. In it the costæ or fissures between them are more numerous and are not confined to a limited area of the front but occupy it entirely. 2. The costæ do not end peripherally in a prominent papilla or tubule as in *Cribrilina figularis* and *Cribrilina tubulifera*, Hincks. 3. The mouth is more arched above, and the lower lip is either perfectly straight in the older zoœcia or very slightly notched in the middle, corresponding to the termination of the median symphysial fissure, which remains visible in the younger ones. 4. In the transformation of a zoœcium into an avicularium, which, though perhaps not exactly homologous with the large avicularia occasionally seen dispersed between the zoœcia in *Cribrilina figularis* as noticed by Mr. Hincks and by Dr. Heller, answers the same purpose.

§ *β*. Front, with punctures in more or less distinct transverse rows.

(4) *Cribrilina labiosa*, Busk, var. *α, fragilis* (Pl. XIX. fig. 4).

Character.—Zoarium flexuose, delicate, white. Zoœcia barrel-shaped, front cribrate, with the openings in irregular transverse rows. Orifice horizontal, wide transversely; peristome much thickened on the sides and in front where it is produced into a wide projecting spout, and altogether deficient behind; an avicularium on each side deeply immersed within the orifice, with a curved, triangular, pointed mandible; no perceptible chitinous operculum.

Habitat.—Simon's Bay, Cape of Good Hope.

Though widely different in appearance the essential characters in the present form are exactly the same as those of the typical *Lepralia labiosa* (Brit. Mus. Cat. vol. i. p. 82, pl. xcv. figs. 4, 5). But in the description there given, the intra-oral avicularia and cribrate condition of the wall, which in that form is covered with a deep brown, thick epitheca are omitted, as is also the apparent absence of a chitinous operculum.

The species might well be regarded as the type of a distinct genus.

(5) *Cribrilina monoceros*, Busk, sp. (Pl. XIX. fig. 8).

Lepralia monoceros, Brit. Mus. Cat., vol. i. p. 72, pl. xciii. figs. 5, 6; Macgilliv., Nat. Hist. Vict., Dec. iv. p. 32, pl. xxxviii. figs. 1–2.

(?) *Lepralia larvalis*, Ibid. p. 30, pl. xxxvii. fig. 5.

Character.—Zoœcia deeply immersed, broad ovate, narrowing below. Primary mouth suborbicular and sinuated below; afterwards coarctate or horse-shoe shaped, and more deeply sinuated, with a sharp, internal (articular?) denticle on one or both sides; peristome thick; a short, thick, cylindrical process, usually only on one, but sometimes on both sides immediately outside the peristome, for the articulation of a long club-shaped

spine. In the older zoœcia the peristome in front rises into a strong, conical, rostriform process, upon which occasionally a small avicularium (with a triangular mandible) is developed below the apex in front; on many zoœcia an immersed avicularium (with an obtuse duck-bill shaped mandible) directed obliquely downwards. Wall of zoœcium cribriform, the large perforations surrounded with a thickened border. Zoœcia about 0″·02 wide. Orifice 0″·0075.

Habitat.—Station 163B, Port Jackson 35 fathoms, hard ground (on a *Carbasea*). Off Marion Island) surrounding the stem of an Alcyonarian, but not attached in either case). Station 303, lat. 45° 31′ S., long. 78° 9′ W.; 1325 fathoms, blue mud. Station 253, lat. 38° 9′ N., long. 156° 25′ W., 3125 fathoms (on a manganese nodule). Station 313, lat. 52° 20′ S., long. 68° 0′ W., 55 fathoms, sand. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel.

The specimen from Station 303 is more delicate, and the different parts are much less developed.

It might be a question whether the numerous forms that would come under § *β* should not be considered generically distinct from the fissured ones.

Family XIX. MICROPORELLIDÆ.

Microporellidæ (pars), Hincks, Brit. Mar. Polyz., p. 204.
Eschariporidæ (pars), Smitt.
Celleporidæ (pars), Johnst., &c.
Membraniporidæ (pars), Busk.
Porinidæ (pars), d'Orb., Smitt.

Character.—Mouth semicircular or coaretate, with an entire straight lower border; a lunate fimbriated median pore. Zoarium erect and bilaminar, or crustaceous and adnate.

[I have ventured to modify Mr. Hincks' definition for the purpose of limiting it to such escharine forms as have a true lunate pore. Consequently, as here understood, it corresponds with Prof. Smitt's genus *Porellina* (Florid. Bryoz., p. 27). As thus constituted it appears to me to form a very natural group, divisible into two or perhaps three genera or sub-genera, distinguished by the presence of a vibracular or of a quasi-avicularian organ on one side of the front sometimes absent; and in part by the shape of the mouth.]

The Family here contains the following genera:—

§ *α*. Erect, bilaminar.

1. *Flustramorpha*, Gray.
   (1) *Flustramorpha marginata* (Krauss) (Pl. XX. fig. 8).
   (2) *Frustramorpha hastigera*, n. sp.? (Pl. XXI. fig 7).

§ *β*. Crustaceous.

2. *Microporella*, Hincks.

(1) *Microporella personata* (Busk).
(2) *Microporella malusii* (Audouin).
(3) *Microporella ciliata* (Pallas).

The peculiar habit of growth of the *Flustra marginata* of Krauss, and which is also presented in the very closely allied *Eschara flabellaris*, Bk., was apparently regarded by Dr. Gray as sufficient for a generic distinction. But that it is not so is obvious from the circumstance that a similar condition obtains in species belonging to widely distinct genera.

It appears to me, therefore, convenient to merge all the erect bilaminar Microporellidan species, whether with or without the flexible fasciculate stem and marginal bundles of tubes, into one group for which Dr. Gray's name might be retained, but which, since they agree in all more essential characters, should perhaps be regarded more in the light of a sub-genus than as absolutely distinct from *Microporella*.

§ *a*. Erect, bilaminar.

1. *Flustramorpha*, Gray.

Flustramorpha, Gray.
Flustra (sp.), Krauss.
Eschara (pars), Auctt.
Mastigophora (sp.), Hincks.

Character.—Zoarium erect, radicate, bilaminar, composed of irregular lobes, bordered and loosely interconnected by chitinous tubes; mouth coarctate; a lateral pouch-like vibracularium.

(1) *Flustramorpha marginata*, Krauss (sp.) (Pl. XX. fig. 8).

Flustra marginata, Krauss, Corall. und Zooph. d. Südsee, p. 35, fig. 3.
Flustramorpha marginata, Gray.

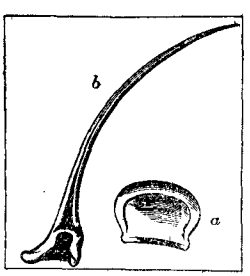


FIG. 39.—*Flustramorpha marginata*. *a*, Operculum; *b*, mandible.

Character.—Zoarium composed of strap-shaped lobes dividing more or less regularly in a furcate manner, and bordered by a bundle of chitinous tubes continuous downwards into a peduncle. Zoœcia broad, ovate, or subhexagonal, flattened in front, and separated by shallow sulci. Mouth arched above, contracted below (coarctate); lower border straight, entire, smooth; a lunate pore whose lower edge is toothed; on one side of the front a large pouch-like vibraculum with a long setose flagellum. Surface finely granular. Oœcia globose, prominent, though slightly immersed at the base.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms, green sand. Off Marion Island, 50 to 75 fathoms.

[Natal, Bolton; South Africa, Krauss].

(2) *Flustramorpha hastigera*, n. sp. ? (Pl. XXI. fig. 7).

† *Porellina ciliata*, Smitt, Florid. Bryoz., p. 26, pl. vi. figs. 126–129.

Character.—Zoarium ramose, branches short, ligulate, expanding at the ends, dichotomous. Zoœcia broad ovate, very convex, surface granular. Mouth semicircular, lower border straight, entire; peristome slightly thickened; three or four oral spines above, (often absent). The lunate pore close below the mouth. An aviculario-vibracular organ on one side, the basal part of the mandible triangular, the apex being turned up at a right angle and produced into a spear-shaped acute flagellum.

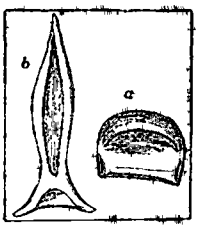


FIG. 40.—*Flustramorpha hastigera*. *a*, Operculum; *b*, mandible.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud.

In the general character of the zoœcia this form very closely resembles *Microporella ciliata*, and even in the vibraculoid character of the avicularium, a close correspondence in some respects exists, for in the latter species the acute mandible of the lateral avicularium, as noticed by Mr. Hincks, "is often prolonged into a slender vibraculoid spine or process." And in like manner in *Flustramorpha hastigera* what might be termed the triangular mandible turns up at the apex, and is produced into a beautiful spear-shaped blade of considerable length, whilst the horizontal basal part forms a fork by which it is articulated and furnished with muscles, in such a way as to admit of motion only in one plane, and to be shut down upon the rostral portion of the avicularium.

Precisely the same conditions obtain in *Flustramorpha flabellaris*, Bk., and *Flustramorpha patagonica*, n. sp.? except that in these two forms, as in *Microporella ciliata*, the flagelliform prolongation is not turned up so abruptly. It is curious to remark that this appendage is almost exactly like that of the anterior immoveable spine of *Lepralia spathulifera*, Smitt. In all these cases, therefore, this form of *flagellum* is apparently adapted only for defensive purposes.

§ *B.* Crustaceous.

2. *Microporella*, Hincks.

Microporella (pars), Hincks, 1877.
Cellepora (pars), Linn.; Audouin.
Lepralia (pars), Johnst.; Busk, &c.
Escharina (pars), Milne-Edw.; Gray.
Herentia (sp.), Gray.
Reptoporina (pars), D'Orbigny.
Porina, *Porellina*, Smitt.

Character.—Zoarium erect and bilaminar, or encrusting and adnate. Mouth semi-

circular, with a straight entire lower border, with or without oral spines. An aviculario-vibracular organ on one side of the front with the mandible forked at the base; or unarmed.

(1) *Microporella personata*, Busk, sp.

Lepralia personata, Bk., Brit. Mus. Cat., p. 74, pl. xc. figs. 2, 3, 4.
Microporella ciliata, var., Hincks, Brit. Mar. Polyz., vol. i. p. 209.

Character.—Zoœcia immersed, oblong, surface punctured. Mouth semicircular, lower lip straight, prominent, entire; five to seven oral spines above; a long avicularian vibraculum on one or both sides of the front. Oœcium smooth, cucullate; in the fertile cells the lower lip is much produced in front.

Habitat.—Station 208, lat. 11° 37′ N., long. 123° 31′ E., 18 fathoms, blue mud (on a dead shell).

[Falkland Islands, 4 to 10 fathoms, on stones and *Fuci*, Darwin.]

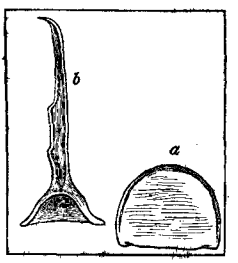


FIG. 41.—*Microporella personata*. *a*, Operculum; *b*, mandible.

Though perhaps closely related to *Microporella ciliata*, I think the great and constant difference in the fertile cells sufficient as a specific distinction.

(2) *Microporella malusii*, Audouin (sp.).

Cellepora malusii, Audouin.
Lepralia biforis, Johnst.
Herentia biforis, Gray.
Escharina cornuta, d'Orb.
Reptoporina malusii, d'Orb.
Lepralia malusii, Busk, Heller, Manzoni, &c.
Porina malusii, Smitt.
Microporella malusii, Hincks.

Character.—Cells ovate, truncate at each end; front, especially round the margin, punctured with numerous stelliform pores; a large central lunate pore; mouth semicircular, straight below, sometimes armed with three or four oral spines, which are occasionally forked. Oœcium smooth, sometimes porcellanous, grooved or areolated round the upper border, adnate to the front of the cell above.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand and gravel. Station 135c, off Nightingale Island, Tristan da Cunha, 110 to 150 fathoms.

[Cosmopolitan.]

(3) *Microporella ciliata*, Pallas (sp.).

Eschara ciliata, var. *β*. Pall. Elench.
Cellepora ciliata, Linn.
Lepralia ciliata, Johnst., Bk., W. Thompson, Macgilliv., Gray.
„ *insignis*, Hassall.
„ *lunata*, Macgilliv.
„ *utriculus*, Manzoni.
Escharina vulgaris (pars), Milne-Edw.
(?) *Flustra genisii*, Audouin.
Porina and *Porellina ciliata*, Smitt.
Microporella ciliata, Hincks.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha, 110 to 150 fathoms. [Cosmopolitan.]

Family XX. ESCHARIDÆ.

Escharidæ (pars), Johnst., d'Orb., Busk, Smitt, Hincks, &c.
Myriozoidæ (pars), Smitt, Hincks.

Character.—Zoarium calcareous, radicate or fixed; erect, uni- or bi-laminar, foliaceous or ramose; or crustaceous, loosely attached or adnate. Zoœcia urceolate, front entirely calcified.

§ 1. Lower lip of primary orifice entire.

§§ *α*. Erect, bilaminar.

1. *Eschara*, Pallas.

(1) *Eschara elegantula*, d'Orbigny (Pl. XX. fig. 6).
(2) *Eschara gracilis*, Milne-Edwards (Pl. XXI. fig. 6).

§§ *β*. Crustaceous, unilaminar.

2. *Lepralia*, Johnston.

(*a*) Free or loosely attached.

(1) *Lepralia celleporoides*, n. sp. (Pl. XVII. fig. 4).
(2) *Lepralia japonica*, n. sp. (Pl. XVII. fig. 5).
(3) *Lepralia tuberosa*, n. sp. (Pl. XVII. fig. 7).
(4) *Lepralia dorsiporosa*, n. sp. (Pl. XVIII. fig. 4).

(*b*) Adnate.

(5) *Lepralia feegeensis*, n. sp. (Pl. XXII. fig. 9).
(6) *Lepralia margaritifera* (Quoy and Gaymard).
(7) *Lepralia incisa*, n. sp. ? (woodcut).
(8) *Lepralia lonchæa*, n. sp. (woodcut).
(9) *Lepralia marsupium*, Macgillivray (woodcut).

3. *Chorizopora*, Hincks.

(1) *Chorizopora brongniartii* (Audouin).
(2) *Chorizopora hyalina*, var. *bougainvillei*, Busk (Pl. XXII. fig. 4).
(3) *Chorizopora honolulensis*, n. sp. (Pl. XXII. fig. 12).

4. *Porella*, Gray.

(1) *Porella lævis*, var. *subcompressa*, Hincks (Pl. XX. fig. 3).

5. *Escharoides*, Smitt.

(1) *Escharoides occlusa*, n. sp. (Pl. XXI. fig. 8).
(2) *Escharoides verruculata* (Smitt).

6. *Smittia*, Hincks.

(*a*) Bilaminar.

(1) *Smittia tenuis*, n. sp.? (Pl. XX. fig. 1).

(*b*) Unilaminar.

(2) *Smittia smittiana*, n. sp. (Pl. XVII. fig. 3).
(3) *Smittia marsupialis*, n. sp. (Pl. XVIII. fig. 1).
(4) *Smittia transversa*, n. sp. (Pl. XVIII. fig. 7).
(5) *Smittia marionensis*, Busk (Pl. XVIII. fig. 6).
(6) *Smittia jacobensis*, n. sp. (Pl. XIX. fig. 7).

(*c*) Adnate.

(7) *Smittia oratavensis*, n. sp. (Pl. XXII. fig. 1).
(8) *Smittia stigmatophora*, n. sp. (Pl. XXII. fig. 6).
(9) *Smittia graciosa*, n. sp.? (Pl. XXII. fig. 13).

7. *Mucronella*, Hincks.

(*a*) Bilaminar.

(1) *Mucronella contorta* (Busk) (Pl. XX. fig. 9).
(2) *Mucronella pyriformis*, n. sp. (Pl. XX. fig. 5).

(*b*) Unilaminar, free or loosely attached.

(3) *Mucronella quadrata*, n. sp. (Pl. XVIII. fig. 5; Pl. XVII. fig. 8).
(4) *Mucronella delicatula*, n. sp. (Pl. XVIII. fig. 2).
(5) *Mucronella rostrigera*, n. sp. (Pl. XIX. fig. 2).
(6) *Mucronella bisinuata* (Smitt) (Pl. XIX. fig. 5).
(7) *Mucronella castanea*, n. sp. (Pl. XIX. fig. 6).
(8) *Mucronella magnifica*, n. sp. (Pl. XVIII. fig. 3).

(*c*) Adnate.

(9) *Mucronella canalifera*, n. sp. (Pl. XXII. fig. 2).
(10) *Mucronella tricuspis*, Hincks (Pl. XXII. fig. 3).
(11) *Mucronella simplicissima*, n. sp. ? (Pl. XXII. fig. 5).
(12) *Mucronella ventricosa*, var. *multispinata*, Busk (Pl. XXII. fig. 11).

8. *Aspidostoma*, Hincks.
Aspidostoma giganteum (Busk) (Pl. XXXIII. fig. 3).

§ 2. Primary mouth notched or sinuated below.

9. *Schizoporella*, Hincks.
(*a*) Bilaminar.
(1) *Schizoporella furcata*, n. sp. (Pl. XXI. fig. 5).
(*b*) Unilaminar, free or loosely attached.
(2) *Schizoporella nivea*, n. sp. (Pl. XVII. fig. 1).
(3) *Schizoporella longispinata*, n. sp. (Pl. XVII. fig. 2).
(4) *Schizoporella auriculata* (?) Hassall, var. *alba*, nov. (Pl. XIX. fig. 1).
(5) *Schizoporella jacksoniensis*, n. sp. (Pl. XIX. fig. 3).
(6) *Schizoporella tenuis*, n. sp. (Pl. XX. fig. 10).
(*c*) Adnate.
(7) *Schizoporella elegans*, d'Orbigny (Pl. XXII. fig. 8).
(8) *Schizoporella marsupifera*, n. sp. (Pl. XXII. fig. 14).
(9) *Schizoporella cecilii* (Audouin).
(10) *Schizoporella circinata* (Macgillivray) (woodcut).
(11) *Schizoporella triangula*, Hincks.

10. *Gephyrophora*, n. gen.
Gephyrophora polymorpha, n. sp. (Pl. XXXIV. fig. 2).

11. *Myriozoum*, Donati.
(1) *Myriozoum honolulense*, n. sp. (Pl. XXV. fig. 2).
(2) *Myriozoum immersum*, n. sp. (Pl. XXV. fig. 4).
(3) *Myriozoum simplex*, n. sp. (Pl. XXV. fig. 1).
(4) *Myriozoum marionense*, n. sp. (Pl. XXIII. fig. 6).

12. *Haswellia*, n. gen.
(1) *Haswellia australiensis* (Haswell) (Pl. XXIV. fig. 9).
(2) *Haswellia auriculata*, n. sp. (Pl. XXIV. fig. 10).

13. *Tessaradoma*, Norman.

Tessaradoma boreale (Busk) (Pl. XXIV. fig. 8).

14. *Gemellipora*, Smitt.

(*a*) Erect and ramose.

(1) *Gemellipora glabra*, Smitt (Pl. XXV. fig. 3).

(*b*) Adnate.

(2) *Gemellipora cribritheca*, n. sp. (Pl. XXXIII. fig. 5).

§ 1. Lower lip of primary orifice entire.

Primary mouth persistent, lower border entire usually straight; operculum semicircular. Oral avicularia, when present, median, and external to the peristome.

§§ a. Erect, bilaminar.

1. *Eschara*, Pallas.

Eschara (pars), Ray, Johnst., Lamk., d'Orb., Busk, Smitt, Milne-Edw., &c.
Cellaria (pars), Reuss.
Acropora (pars), Reuss.
Lepralia (pars), Hincks, Smitt, &c.

Character.—Zoarium erect (sometimes decurrent); foliaceous or ramose compressed, bilaminar.

(1) *Eschara elegantula*, d'Orbigny (Pl. XX. fig. 6).

Eschara saccata, Bk., Ann. Nat. Hist., ser. 2, vol. xviii., p. 33, pl. 1. fig. 5, 1856; Sars. Beskr. o. n. Norske Polyzoer, p. 6, 1862.
? *Eschara elegantula*, d'Orbigny (*teste* Smitt), Palæont. Franç., p. 102; Smitt, Kritisk Förteckn., pp. 24, 154.

Character.—Zoarium (of considerable size), branched dichotomously in one plane, branches of various breadths, widening at the ends. Zoœcia cylindrical or barrel-shaped, orifice terminal, horizontal (looking directly upwards) arcuate. The front of zoœcium nearly entirely occupied by a large pouch-like avicularium, with a semicircular mandible, pointing forwards. Oœcia immersed, convex cucullate. The entire surface smooth and shining.

Habitat.—Station 48, lat. 43° 4′ N., long. 64° 5′ W., 51 fathoms, rock.

[Banks of Newfoundland, d'Orbigny; Spitzbergen, Greenland, Finmark, Forell, Sars, M'Andrew.]

(2) *Eschara gracilis*, Lamarck (Pl. XXI. fig. 6).

Eschara gracilis, Lamk.; Lamx.; Blainv.; Milne-Edw.; Brit. Mus. Cat., Macgilliv., &c.
Cellaria and *Acropora coronata*, Reuss.
? *Eschara buskii*, Tenison Woods, Journ. Roy. Soc. Vict.

Character.—Zoarium much and irregularly branched in various directions. Branches subcompressed, varying in breadth from 0″·15 to ·25. Zoœcia at the growing extremity ventricose and subtubular towards the orifice; in all other parts completely immersed, so that no outlines are discernible, the thickened annular orifices alone projecting from a level surface, which is closely and uniformly pitted. Orifice suborbicular, peristome very thick, annular, entire, and on it are placed from five to eight small circular avicularia on as many tubercular elevations. An elongate sublateral pore or fissure some distance below the orifice. Oœcia—?

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 49 fathoms, green mud. Station 162, off East Moncœur Island, 38 fathoms, sand and shells.

[Bass Strait, Voy. of Rattles.; tertiary fossil, Reuss; Miocene? Tenison Woods.]

Although Dr. Reuss describes a central pore of large size, it is not represented in his figure of *Acropora coronata*. But there can, I think, be little doubt that the present species is identical with the tertiary form, as well as with that described by the Rev. Tenison Woods from the Mount Gambier deposits, under the name of *Eschara buskii*.

If the peculiar characters of this form be regarded as of generic value, which I think they might be, Reuss' appellation *Acropora* would be very appropriate.

§§ *β*. Crustaceous, unilaminar.

2. *Lepralia*, Johnston.

Lepralia, Hincks, Smitt.
,, (pars), Brit. Mus. Cat., Auctt.
Eschara (pars), Auctt.
Hemeschara (pars), Busk, &c.

Character.—Zoarium unilaminar, erect or crustaceous, and loosely or wholly unattached; or adnate with the zoœcia, incomplete behind.

(*a*) Unilaminar, erect or crustaceous, free or loosely attached (hemescharan).

(1) *Lepralia celleporoides*, n. sp. (Pl. XVII. fig. 4).

Character.—Zoarium unattached, sometimes one layer overgrowing another. Zoœcia completely immersed, convex in front, separated by wide and deep sulci, at the bottom of which are large pores or cancelli. Zoœcia broadly oval, surface entire, finely granular, except a very large central subreniform or orbicular pore, which in the natural state is closed by a delicate membrane, and has a slightly raised border. Orifice coarctate, rostriform. In the older cells a tubercular elevation immediately below the mouth. An immersed avicularium is placed in the sulcus between each pair of cells, on a level with the orifice, with a duck-bill shaped mandible, directed usually vertically upwards, but occasionally in other directions.

Habitat.—Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

(2.) *Lepralia japonica*, n. sp. (Pl. XVII. fig. 5).

Character.—Zoarium thick, unattached, covered with a rather thick, yellowish-brown, opaque chitinous epitheca. Zoœcia, in front, pyriform, broadly truncate below, slightly convex or tumid. Surface beneath the epitheca sparsely but uniformly punctured. Orifice somewhat immersed, arched; lower lip nearly straight, entire. On the dorsal aspect the zoœcia are quadrilateral and nearly square; surface punctured. Interzoœcial wall with numerous pores or plates. Oœcia inapparent. Zoœcia about 0″·05 × ·025. Orifice 0″·01.

Habitat.—Cobie, Japan, 8 to 50 fathoms.

(3) *Lepralia tuberosa*, n. sp. (Pl. XVII. fig. 7).

Character.—Zoarium very thick and coarse-looking, attached by long radical tubes springing from the back of the zoœcia. Zoœcia viewed in front broadly oval or arched above and much contracted below the middle. Convex, separated by moderately deep sulci; obscurely punctured round the border and at the base of the tuberosity. Orifice orbicular with three small points on the lower lip. Operculum rounded or arched above and contracted at the lower part, with a projecting point on either side (continuations of the marginal rim); with a crescentic, transverse, punctured and bordered area, and several faint longitudinal rugæ, the membrane very finely punctured all over. Peristome very thick, supporting on each side towards the front a small circular, slightly elevated avicularium (with a short duck-bill shaped mandible); four strong articulated oral spines above. On the front of the zoœcium, when mature, a very large conical hollow protuberance or tuberosity supporting one or several avicularia on the sides and near the summit (but not on it). These avicularia differ in size and direction, but all have a short, broad, rounded mandible. In the older zoœcia, besides the enormously developed main tuberosity, several others appear, all supporting similar avicularia. On the dorsal aspect the zoœcia appear more or less hexagonal, with an acute angle at the top and bottom. The surface is punctured, and presents a large subclithridiate aperture from which a long cylindrical chitinous radical tube issues. Orifice about 0″·01 wide.

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

(4) *Lepralia dorsiporosa*, n. sp. (Pl. XVIII. fig. 4).

Character.—Zoarium thick, epitheca white. Zoœcia elongated, hexagonal in front, and separated by thin raised septa; a small triangular notch or fold in the centre above the orifice; behind, the zoœcia are broadly ovate. Anterior surface flat but

not depressed, punctate, punctures very regularly quincuncial. Orifice semicircular, slightly coarctate, about 0″·01 wide, lower lip straight entire or sometimes showing a few very shallow notches close to the angle. A minute internal conical tooth (? articular) on each side. On some of the cells a small immersed avicularium on one or both sides of the orifice, of an oval form (with a triangular mandible looking downwards). Dorsal surface vitreous, transversely wrinkled, with a large oval or reniform opening closed by a perforated membrane and with a raised but not thickened border, and besides this, one or several small circular pores also with raised margins, from which proceed flexible radical tubes, the wall of which is very finely annulated. Lateral interzoœcial plates, small and circular, eight in number, disposed in alternate rows (four to each of the contiguous cells).

Habitat.—Station 186. Cape York, lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms, coral mud.

This fine species exemplifies, in the most striking manner, the structure of a hemescharine zoarium. It is loosely attached, apparently by long flexible radical tubes, to subjacent bodies, probably coral, and besides these tubes each zoœcium has a gigantic "perforated plate," the function of which, in such a situation, appears to be very obscure. It is clear, however, that it is not for the purpose of keeping up any communication with a contiguous zoœcium, although in structure it precisely resembles those "Rosettenplatten" which occur on the walls of contiguous cells and have been supposed to be for the purpose of communication between the two.

(*b*) Adnate (lepralian).

(5) *Lepralia feegeensis*, n. sp. (Pl. XXII. fig. 9).

Character.—Zoœcia very large, 0″·05, completely immersed so as to form an almost level surface, slightly convex in front, oblong and rectangular, disposed in linear series; surface smooth, very finely and obscurely punctured. Mouth large, slightly coarctate, with a straight prominent lower lip. On many of the zoœcia, on each shoulder, on the sides of the orifice, a horizontal immersed avicularian (with an elongated acute mandible pointing directly inwards). Oœcia inapparent.

Habitat.—Station 208, lat. 11° 37′ N., long. 123° 31′ E., 18 fathoms, blue mud (on a dead shell).

[Hongkong, Dr. Harland.]

A very remarkable form, in which is well displayed the mode in which the marginal growth of the colony is effected. Each of the contiguous series of zoœcia is produced a long way in front of the last inhabited one, in a perfectly smooth chitinous expansion, extending to the length of two or three of the zoœcia, and in which scarcely any indica-

tion of the future differentiation into separate cells is to be observed, except in the part immediately continuous with the last inhabited zoœcium, a faint trace marking the outline of the future mouth, and a still fainter indication of the distal limit of the zoœcium; beyond this no indications even of this faint kind are to be seen.

(6) *Lepralia margaritifera*, Quoy and Gaymard (sp.).

Flustra margaritifera, Quoy and Gaymard, Voy. de l'Uranie, pl. 92, figs. 7, 8.
Lepralia margaritifera, Bk., Brit. Mus. Cat., vol. ii. p. 72, pl. ci. figs. 5, 6.

Character.—Cells deeply immersed, with a row of marginal punctures; front of cell raised into an elevated umbo, on the upper side of which is often a small avicularium with a rounded mandible and numerous larger and smaller, mostly retentive avicularia irregularly distributed; mouth large, suborbicular, with a thickened margin. Oœcium umbonate.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel.

[Tierra del Fuego, Falkland Islands, Darwin; Kerguelen Island, Eaton.]

(7) *Lepralia incisa*, n. sp.?

Character.—Zoœcia quincuncial, ovate; very convex, thick interzoœcial septa. Surface closely pitted (not punctate). Orifice arched above, slightly contracted below; the lower border slightly concave, a very minute articular notch on each side. Peristome even with the surface, very slightly thickened; on each side of the orifice a small oval immersed avicularium.

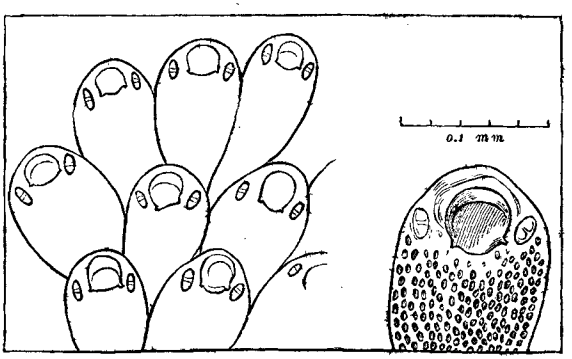


FIG. 42.—*Lepralia incisa.*

Habitat.—Inaccessible Island, 60 to 90 fathoms.

The collection affords only a single specimen of this species parasitic apparently on a white coral. At first sight it resembles some varieties of *Schizoporella ansata*, but the form of the oral orifice is quite different, belonging to the type assigned to *Gemellipora* by Prof. Smitt, and represented in his *Gemellipora lata* (Florid. Bryoz., p. 36, pl. vii. fig. 157), the peculiarity of the Gemelliporan orifice consisting in the presence of a minute articular notch instead of a tooth on each side, and the deep excavation of the lower border. But the broad quadrangular form of the orifice in this case contrasted with its elongate pyriform shape in *Gemellipora glabra*, &c., and the truly lepralian habit of the growth lead me rather to place it under the genus *Lepralia* as here understood. The existence of an avicularium on each shoulder of the cell is of course common to numerous species. In their small size in the present species they more resemble those of *Lepralia woodiana*, Bk., than any other. As the only specimen in the collection is dead, I have been unable to avail myself of the characters afforded by the chitinous parts and can only supply instead the accompanying figure of the oral orifice.

(8) *Lepralia lonchæa*, n. sp.

Character.—Zoarium adnate (on shell). Zoœcia immersed and widely ventricose below, produced and contracted, almost subtubular above, with the orifice directed forwards. Mouth rounded oblong, with a minute articular notch on each side below; lower border entire, slightly curved; peristome thin, raised all round, sometimes slightly channelled in front. On many zoœcia, on one side of the neck-like peristome, an upright avicularium with a long spear-shaped mandible pointing directly upwards. Operculum about 0·02 mm. in diameter, suborbicular, with a minute tubercle on each side corresponding to the articular notches.

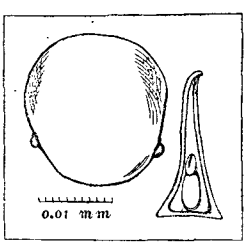


FIG. 43.—*Lepralia lonchæa*. Operculum and mandible.

Habitat.—Admiralty Islands, lat. 2° 0′ S., long. 147° 20′ E.

The elevated peristome is like that which affords the main character of Mr. Hincks' artificial genus *Phylactella*, but the shape of the oral orifice is, with the exception of the two little articular notches, so precisely like that of *Lepralia pallasiana* and *Lepralia pertusa*, that taking also into account the presence of avicularia, I have thought that it should be classed with the other forms to which Prof. Smitt and Mr. Hincks have limited the generic name *Lepralia*. It is very closely allied to the preceding species, but the form of the cells, the produced oral part and the elevated peristome, together with the altogether different avicularia, render them manifestly distinct. To the same group perhaps might be referred *Gemellipora lata* and *Discopora pertusa* (Smitt, Florid. Bryoz., p. 72, pl. xii. fig. 240), [? *nec* Auctt.].

(9) *Lepralia marsupium*, Macgillivray.

Lepralia marsupium, Macgilliv., Nat. Hist. Vict., Dec. iv. p. 22, pl. xxxv. fig. 4.
Porella marsupium, Hincks; Macgilliv., Proc. Roy. Soc. Vict., pt. 3, 1882, pl. i. fig. 2.
? *Porella minuta*, Norman.
Schizoporella marsupium, S. O. Ridley, Proc. Zool. Soc., 1881, p. 48.

Character.—Zoœcia ventricose, subquadrangular, deeply immersed, surface granular; primary orifice arched above, with a straight or slightly sinuated lower border, in front of which is a pouch-like avicularium with a semicircular mandible, placed horizontally. Three or four articulated marginal spines above (usually detached). Oœcia (very numerous) globose, smooth. Operculum semicircular, the lower border with two very obtuse angles.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel. [Australia, Macgillivray.]

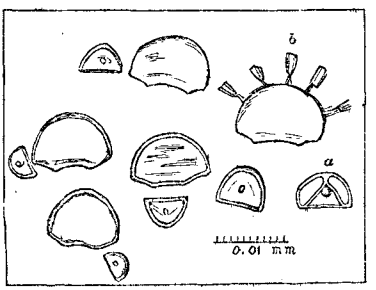


FIG. 44.—*Lepralia marsupium*.
a, Mandible of *Porella compressa*.
b, Operculum and oral spines of *Lepralia marsupium*.

At first sight this form might readily be taken for a *Porella*, as in fact it is considered by Mr. Hincks, who also suggests that the Australian form is nearly related to Dr. Norman's *Lepralia minuta* from Guernsey and Shetland. This I think is highly probable. But neither Mr. Hincks in his description of *Porella marsupium* (Ann. and Mag. Nat. Hist. ser. 5, vol. viii. p. 123, 1881) nor Mr. Norman make any mention of the oral spines noticed by Mr. Macgillivray, which are present in the Challenger specimen on the marginal cells. Mr. Hincks further speaks of a tooth on the lower margin, which I should imagine would in his system have made the species either a *Mucronella* or a *Smittia*, but this I think is an error into which I at first fell myself; for in the Challenger specimen, the apparent tooth is in reality merely the projection upwards of the lower border of the median avicularium, which appears to occupy the same position, and to stand in the same relation to the mouth, as the median avicularium does in *Eschara foliacea* and not to be within its verge as in the typical *Porellæ*. In all the true *Porellæ*, moreover, the avicularian mandible presents a minute but constant character (not altogether however confined to that genus), which is wanting in the mandible of *Lepralia marsupium*, viz., the existence of a curved chitinous rod on each side of the central foramen, as shown at *a*, in the accompanying woodcut (fig. 44) which represents the mandible of *Porella compressa*. The existence of oral spines is clearly proved by their chitinous remains as shown at *b*.

3. *Chorizopora*, Hincks.

Chorizopora, Hincks, Brit. Mar. Polyz., p. 222.
Mollia (sp.), d'Orb., Smitt, *nec* Lamx.
Flustra (sp.), Audouin.
Lepralia (sp.), Brit. Mus. Cat., Macgilliv., Hassall, Johnst., Gray, &c.
Hippothoa (pars), Smitt.
Schizoporella (pars), Hincks.

Character.—Zoœcia often distinct, connected by hollow calcareous processes. Mouth semicircular or suborbicular, with a straight or sinuated lower border. Oœcial orifice crescentic. Wall of zoœcia usually transversely wrinkled.

The name *Mollia*, originally applied by Lamouroux to two or three species of Membranipora, has been used in so many senses since, that I quite agree with Mr. Hincks in disusing it. But the genus as it stands is at present ill defined. I include under it the various forms, more or less closely allied to *Lepralia hyalina*, Auctt.

(1) *Chorizopora brongniartii*, Audouin (sp.).

Chorizopora brongniartii, Hincks.
Flustra brongniartii, Audouin, Expl. i. p. 240.
Lepralia tenuis, Hassall.
Lepralia assimilis, Johnst.
Lepralia brongniartii, Bk., Brit. Mus. Cat., vol. i. p. 65, pl. lxxxi. figs. 1–5, Heller, Manzoni.
Lepralia capitata, Reuss.
Mollia brongniartii, d'Orbigny.

Habitat.—Simon's Bay, Cape of Good Hope, 18 fathoms (on a dead shell).

[Mediterranean, Adriatic, North Atlantic, lat. 47° 35′–58′ N., long. 7° 6′ W., 89–205 fathoms. Coasts of France and Britain; Coralline Crag; Pliocene at Volterra and Miocene at Castrocaro.]

Savigny's figure ("Egypte," pl. x. fig. 6), appears to me more like a variety of *Chorizopora hyalina*, as it shows no trace of avicularia.

(2) *Chorizopora hyalina*, var. *bougainvillei* (Pl. XXII. fig. 4).

Escharina bougainvillei, d'Orbigny, Amér. Mérid. p. 12, pl. iv. figs. 9–12.
Lepralia hyalina, var. *bougainvillei*, Bk., Kerguelen Polyz., p. 5, pl. x. fig. 10.

Habitat.—Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud. Station 315, lat. 51° 40′ S., long. 57° 50′ W.; 12 fathoms (on a species of *Carbasea*). Station 135A, off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel.

[Swain's Bay, Kerguelen, Eaton.]

(3) *Chorizopora honolulensis*, n. sp. (Pl. XXII. fig. 12).

Character.—Zoœcia erect and subtubular above, deeply immersed at the base, and ventricose. Large open spaces or cancelli in the interzoœcial sulci, and constantly a large

one immediately above each zoœcium. Surface very rough and uneven. Primary mouth orbicular, entire; afterwards, by the elevation of the peristome, is formed a deep, infundibuliform cup, at the bottom of which the small primary orifice is visible; peristome thick, entire. Oœcia inapparent.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms (inside a dead shell).

[There is only a single small worn specimen in the collection. I place the species with *Chorizopora* simply on account of the distant zoœcia, but its family position is quite uncertain, though it would appear to come within d'Orbigny's definition of *Mollia*.]

4. *Porella*, Gray.

Porella, Hincks, Smitt (pars), Gray, Brit. Mar. Rad., pp. 127, 128.
Cellepora (pars), Fleming.
Eschara (pars), Sars, Bk., Alder, Smitt, &c.
Hemeschara (pars), Norman.
Lepralia (pars), Bk., &c.

Character.—Zoarium erect ramose, cylindrical or subcompressed; or crustaceous and adnate. A median oral avicularium within the primary mouth, with a semiorbicular or subtriangular mandible.

[The peculiar framework of the mandible, in the genus *Porella*, is shown at *a*, woodcut 44, p. 147.]

(1) *Porella lævis*, var. *subcompressa*, Hincks (Pl. XX. fig. 3).

Character.—Zoarium with the general habit of *Porella lævis*, with the branches subcompressed and bilaminar.

Habitat.—Porto Praya, St. Iago, Cape de Verde, 100 to 150 fathoms.

[The difference between this and the usual cylindrical form of the northern *Porella lævis* is sufficient to mark it as a distinct variety. In the chitinous parts there is no difference except that the avicularian mandible is on the whole larger, and usually exhibits a median tooth on the inside at the top. But it has the same elevated arched form and not the depressed semicircular shape of the mandible in *Porella compressa*.]

5. *Escharoides*, Smitt.

Eschara (pars), Auctt.
Escharoides, Smitt, Hincks. ? Milne-Edw. (pars).

Character.—Secondary orifice situated below, with an avicularium on one or both sides of the notch.

(1) *Escharoides occlusa*, n. sp. (Pl. XXI. fig. 8).

Character.—Zoarium thick, irregularly branched in one plane. Branches varying in breadth from 0″·25 to ·1 with from 5 to 8 zoœcia in the width. Zoœcia distinct, and open towards the ends of the branches or lobes; in the older portions much over-grown with a porcellanous accretion by which the orifice is completely obliterated. The younger zoœcia ovate, broad, surface uneven, widely punctured. Orifice (primary) arcuate with a nearly straight and entire lower lip, or suborbicular; afterwards the lower border becomes sinuate and the peristome much thickened, and on one side of the shallow, oral sinus thus formed a rather large immersed avicularium with a triangular mandible pointing upwards is developed. Oœcia deeply immersed, with several irregular fissures or triangular punctures in front.

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms, hard ground, gravel and shells. Station 186, Cape York, lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms, coral mud. Samboangan, 10 fathoms.

(2) *Escharoides verruculata*, Smitt (sp.).

Cellepora verruculata, Smitt, Florid. Bryoz., pt. 2, p. 50, pl. viii. figs. 170–172.

Habitat.—Station 151, off Heard Island, 75 fathoms, mud.
[West of Tortugas, Gulf of Mexico, Pourtalès].

6. *Smittia*, Hincks.

Eschara (pars), Auctt.
Berenicea (pars), Johnst.
Lepralia (pars), Johnst., Bk., &c.
Escharella, Smitt, Öfv. K. Vet. Ak. Förh. 1873 (*nec Escharella* Gray *nec* d'Orb.).
Smittia, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. iii. p. 160, 1879.

Character.—Zoarium erect bi- or uni-laminar or crustaceous free or adnate. Primary orifice entire, with an internal median denticle. Secondary orifice canaliculate, usually enclosing a median avicularium.

(*a*) Bilaminar (escharan).

(1) *Smittia tenuis*, n. sp. ? (Pl. XX. fig. 1).

Character.—Zoarium dichotomously branched (?) not always in the same plane; compressed. Zoœcia completely immersed, pyriform, bordered by a single row of punctures, surface granular. Mouth pyriform, with a minute internal denticle ? and rarely a median suboral avicularium, with a long spatulate mandible, pointing directly downwards.

Habitat.—Off Bahia, 10 to 20 fathoms.

[The only specimen of this apparently undescribed species is a small dead fragment, containing no chitinous parts, and otherwise in bad condition, so that it is doubtful whether there really is an internal denticle; but the median descending avicularium, of which I cannot see more than one in the entire specimen, renders it almost certain that the form belongs to *Smittia*, or is closely allied to it.]

(*b*) Unilaminar, erect or crustaceous, unattached (hemescharan).

(2) *Smittia smittiana*, n. sp. (Pl. XVII. fig. 3).

Character.—Zoarium quite unattached, foliaceous, expanded. Zoœcia quincuncial, elongated oval, or fusiform. Surface uniformly punctured, epitheca thick and white. Primary orifice suborbicular, rather wider than high, with two lateral notches in the lower lip; secondary clithridiate, peristome much raised all round, but especially on the sides; a median oral avicularium of circular form, with a short duck-bill shaped mandible, deeply seated behind which is an internal rather broad denticle. Oœcium prominent, hemispherical, with an oval or rather reniform circumscribed area in front, within which are usually five converging more or less triangular openings, the borders of which are not thickened. The anterior border of the oœcial mouth straight, joining the lateral elevations of the peristome on each side. On the dorsal aspect, the zoœcia are barrel-shaped and imperforate, and the texture of the hind wall is very coarse and thick. Zoœcia from 0″·02 to ·03 wide × ·04 to ·06 long.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

This beautiful form differs from *Smittia landsborovii*, Johnst.: 1, in the form of the zoœcia, and in their not being separated by septal ridges; 2, in the size and form of the suboral avicularium; 3, and more especially in the primary conformation of the orifice, which in that species has a prominent tooth within the lower lip, with a minute denticle on either side of it (Hincks), whilst in *Smittia smittiana* the lower lip presents two small lateral notches separated by a wide portion of the border, which in a subsequent stage of development appears to be reduced to a comparatively narrow hammer-shaped denticle.

(3) *Smittia marsupialis*, n. sp. (Pl. XVIII. fig. 1).

Character.—Zoœcia serial, quadrilateral, flattened in front, with the oral portion somewhat raised; wall punctured. Orifice, at first suborbicular, entire, with a broad internal median denticle, and two smaller points on the sides; afterwards the peristome

becomes very much elevated on the sides, forming a wide spout-like subtubular projection. Occasionally a small avicularium on one side at the upper part of the front with an acute triangular mandible pointing upwards and inwards. The fertile cells about half the size of the sterile ones, and seated on the front of the larger cells; the oœcium, of small size and globular in form, is recumbent, and leans over to one side, so as not to interfere with the orifice of the supporting zoœcium; its surface is finely punctured, and the anterior lip of the opening much thickened and projecting.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms. Station 313, lat. 52° 20′ S., long. 67° 39′ W., 55 fathoms, sand.

The peculiar situation of the fertile cells on the front of one of the sterile kind is a very remarkable feature; the mouth of these smaller zoœcia is formed exactly in the same way as in the others.

(4) *Smittia transversa* (Pl. XVIII. fig. 7).

Character.—Zoarium expanded, foliaceous. Zoœcia elongated, pyriform, truncate below, rather flattened in front. Surface finely granular, a row of pores round the entire border. Mouth orbicular, a small internal median denticle, and on the lower border in front a small immersed avicularium of an oval form and placed transversely. Dorsal surface entire, porcellanous, wall thick. Interzoœcial pores, 10 to 12, very minute.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

Bears some resemblance to *Lepralia reticulata* in one or other of its varieties; and in the transverse position of the suboral avicularium is like *Smittia affinis*, Hincks.

(5) *Smittia marionensis*, Busk (Pl. XVIII. fig. 6).

Lepralia marionensis, Bk., Brit. Mus. Cat. p. 67, pl. xcvi. figs. 1 and 2.

Character.—Zoarium foliaceous, expanded, flexuose, unattached. Zoœcia ovate, ventricose, no septal ridges; wall thin, punctured, punctures wide apart. Primary orifice suborbicular, with a small almost circular median avicularium on the lower border, and a conical much reclined internal denticle; peristome thickened and elevated; afterwards forming an elevated lip on each side, which is continued around a large suboral avicularium with a duck-bill shaped obtuse mandible pointing vertically downwards. Oœcium distinct, hemispherical, surface smooth, with several more or less triangular converging pores on the front; each pore surrounded with a thickened border. Posterior surface entire, opaque, almost porcellanous.

Habitat.—Prince Edward Island, 80 to 150 fathoms. Station 149D, Royal Sound, Kerguelen Island, 28 fathoms, volcanic mud.

[Marion Island, 80 fathoms, Hooker].

(6) *Smittia jacobensis*, n. sp. (Pl. XIX. fig. 7).

Character.—Zoœcia subrhomboidal; in older parts quite immersed, depressed in front, with the oral region much elevated and subtubular. Surface punctured. Primary orifice subcoarctate or almost orbicular, with an extremely minute spoon-shaped denticle behind the middle of the entire lower lip; two delicate marginal spines above; the peristome soon becomes thickened, at first especially on the sides and in front, with a decided median sinus. The thickening and elevation of the sides of the raised peristome rapidly increase till the prominences on either side meet in the middle, and form a broad bridge in front of the orifice; below the orifice within the abutments of the bridge is developed a sessile median avicularium with a rounded mandible directed downwards. Oœcia small, deeply immersed, with a kidney-shaped perforated area on the front.

Habitat.—Porto Praya, St. Iago, Cape Verde Islands, 100 to 120 fathoms. Off Marion Island, 50 to 75 fathoms. (Parasitic on a *Salicornaria*).

The conformation of the orifice and suboral avicularium, though in some respects like that in *Smittia marionensis* and perhaps *Smittia landsborovii*, differs in the circumstance that in those species the two sides of the elevated peristome never coalesce so as to form a bridge; in *Smittia jacobensis* also the peristome is not continued round the avicularium as it is in those two species, and generally speaking in the whole of the so termed genus *Smittia*, to which, nevertheless, so far as the oral structure is concerned, the present species would seem to belong.

(*c*) Adnate (lepralian).

(7) *Smittia orotavensis*, n. sp. (Pl. XXII. fig. 1).

(?) *Smittia marmorea*, Hincks, Ann. and Mag. Nat. Hist., ser. 4, vol. xx. p. 214, 1877; Brit. Mar. Polyz., vol. i. p. 350, pl. xxxvi. figs. 3–5.

Character.—Zoœcia immersed at the base, erect above. Orifice elithridiate, or widely notched in front; peristome raised, not thickened, a broad denticle within. Surface rugose, finely punctured, with a row of larger marginal pores. An elongated, immersed avicularium on the middle of the front; mandible slender, pointing vertically downwards. Oœcia recumbent, deeply immersed, surface punctured.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud. [Port of Orotava, Teneriffe, W.K.P.; Cornwall and Guernsey, ? Hincks.]

This form, of which many years since I received specimens from the Port of Orotava, through Mr. W. K. Parker, appears to correspond very closely with Mr. Hincks' British

species; the only difference between them is the apparently smaller size of the anterior avicularium. Should the two turn out to be identical, Mr. Hincks' name must, of course, be adopted.

(8) *Smittia stigmatophora*, n. sp. (Pl. XXII. fig. 6).

Character.—Zoœcia completely immersed, flattened in front, irregularly quincuncial; surface shining, with closely placed large circular punctures, which are larger round the border. Primary orifice arched, dentate; secondary clithridiate with a small avicularium with spatulate mandible just within the lower lip, and in front of the hammer-shaped denticle. Oœcia inconspicuous, completely immersed; surface granular and presenting a crescentic or reniform, punctured stigma in front.

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel (on shells).

In some respects resembling *Lepralia* (*Smittia*) *cheilostoma*, Manzoni, as well as *Lepralia* (*Smittia*) *bella*, Busk, it differs from the former in having an avicularium within the lower border of the orifice; in the deeply immersed oœcium with its peculiar stigma, resembling that in many Australian Retepores, as well as in the absence of a raised septum, or even of a sulcus between the zoœcia. It has a dull purplish colour, and is very closely attached to the shell upon which it is growing, and the posterior wall of the zoœcia in a small detached fragment is deficient.

(9) *Smittia graciosa* (Pl. XXII. fig. 13).

? *Porella concinna*, var. *β. gracilis*, Hincks, *loc. cit.*, p. 324, pl. xlvi. fig. 9.

Character.—Zoœcia elongate, oval, attenuated and somewhat raised towards the orifice. Secondary orifice clithridiate, enclosing within the lower border a small circular avicularium with a spatulate mandible, and behind this an internal denticle. Peristome thin, two oral spines above but only in the youngest cells. Surface punctured, the punctures rather distant and uniformly distributed.

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms, hard ground, gravel and shells.

This form appears to bear a strong resemblance to that described by Mr. Hincks. It differs, however, to judge from his figure, in the form of the zoœcia, which in Mr. Hincks' species are apparently longer and slenderer and separated by raised septa, which are entirely wanting in the present form. Notwithstanding this, it is by no means clear that the two are not identical; if so, I should nevertheless be inclined to refer neither to *Porella concinna*, an essential character of which, as indeed is pointed out by Mr. Hincks, is the presence of a row of marginal pores, of which there is no trace either in *Porella concinna β*, or in the present form.

7. *Mucronella*, Hincks.

Berenicea (pars), Fleming.
Lepralia (pars), Johnst., Bk.; &c.
Escharella, Gray (sp.), Smitt.
Discopora (pars), Smitt, Gray.
Mucronella, Hincks, Brit. Mar. Polyz.
Eschara (sp.), Bk.

Character.—Zoarium erect and bi- or uni-laminar; or crustaceous and unattached; or adnate. Orifice mucronate in front.

(*a*) Bilaminar (escharan).

(1) *Mucronella contorta*, Busk (Pl. XX. fig. 9).

Eschara contorta, Bk., Brit. Mus. Cat. I. p. 89, pl. cviii. figs. 1, 2, 3.

Character.—Zoarium thick, lobate, undulate. Zoœcia almost hemispherical in front, surface closely and widely punctate. Mouth orbicular, lower border mucronate. On many of the zoœcia an avicularium with a duck-bill shaped mandible on one or both sides of the orifice, and sometimes a small one quite within its border on one side.

Habitat.—Simon's Bay, Cape of Good Hope.

[Algoa Bay; Natal.]

The internal avicularium varies a good deal in size; it was overlooked when the description of the species in the Brit. Mus. Cat. was drawn up, and is not always present nor visible.

(2) *Mucronella pyriformis*, n. sp. (Pl. XX. fig. 5).

Character.—Zoarium of small size, lobate. Zoœcia pyriform, immersed but separated by deep sulci. On the front a thick rounded elevated ridge surrounds the orifice, and the two sides joining, is continued as a tumid elevation to the bottom. Mouth suborbicular, apiculate in front, with a wide rounded internal denticle; no frontal avicularium.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand.

The above characters are only exhibited distinctly in the younger parts of the zoarium. In most parts the zoœcia are much overgrown so that the surface becomes almost level, the rounded orifices with the thickened annular peristome slightly projecting. And in this state the small apiculate mucro is altogether wanting. Sometimes the zoœcia assume a more or less ovate form. The species is very doubtfully referred to *Mucronella*.

(*b*) Unilaminar, erect or crustaceous unattached (hemescharan).

(3) *Mucronella quadrata*, n. sp. (Pl. XVIII. fig. 5, and Pl. XVII. fig. 8).

Character.—Zoarium closely investing a branch of coral but not attached to its surface; of a white colour. Zoœcia very uniformly serial, rectangular and almost square, separated by very thin septal ridges. Surface convex, uniformly and closely punctate, wall thick, opaque. Orifice orbicular, mucronate, with an acute, curved, internal articular denticle on each side. Occasionally, but very rarely, a large intercalated immersed avicularium with a spoon-bill shaped mandible. Dorsal surface entire, smooth, porcellanous.

Habitat.—Station 172, off Nukalofa, Tongatabu, 18 fathoms, coral mud.

(4) *Mucronella delicatula*, n. sp. (Pl. XVIII. fig. 2).

Character.—Zoarium tubular, free. Zoœcia serial, subquadrangular in front, quite square behind, separated by very thin septal ridges. Anterior surface flattened, surface finely granular with a single row of pores round the border. Orifice orbicular, peristome thin, entire; a rather wide expanded median mucro, and a very minute, rather obtuse, articular tooth on each side within the border of the orifice. On some of the zoœcia, a sessile avicularium on one side of the body with a triangular mandible pointing downwards. Oœcia unknown.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

The orifice in this species is truly orbicular in all stages of growth, and the peristome does not appear to undergo any secondary development. The mucro though within the border of the orifice, is in front of the operculum. In the figure the lateral articular denticles are shown rather too clearly, as in many instances they are scarcely perceptible.

(5) *Mucronella rostrigera*, n. sp. (Pl. XIX. fig. 2).

Character.—Zoarium rather thick, surrounding an *Echinus*-spine, white, and dull; the wall appearing to be formed of excessively fine, interlaced fibres. Zoœcia ovate, distinct, moderately convex. Orifice subtrifoliate, the peristome being raised into a broad tooth on either side, and into a strong conical mucro in front which eventually becomes rostriform and supports a rounded avicularium on the summit. Oœcia subglobose, partially immersed; surface entire with a faintly marked oval elevation on each side below. Operculum nearly circular, 0″·004.

Habitat.—Prince Edward Island, 80 to 150 fathoms.

The rostriform avicularium in this case differs essentially from that in the preceding species, in its being apparently simply a development of an original true mucro and not a subsequent growth altogether below the orifice. The minute structure of the ectocyst is very remarkable. At first sight, with a magnifying power of about 50 diameters, the appearance is something like that of "crackling" china, which is apparently due to the wall being constituted of exceedingly fine calcareous fibres, forming a sort of felted texture not unlike that of a spider's cocoon.

(6) *Mucronella bisinuata*, Smitt (sp.) (Pl. XIX. fig. 5).

Escharella bisinuata, Smitt, Florid. Bryoz., p. 59, pl. xii. fig. 229.

Character.—Zoarium thick, coarse looking, expanded. Zoœcia subserial, irregularly quincuncial, broadly ovate or subrhomboidal in front, oblong posteriorly; the wall is seen to be punctured when the thick epitheca is removed. Orifice coarctate, lower lip straight, with two lateral incisions. Many of the zoœcia with four avicularia, two on the sides near the orifice and two lower down on the front; (mandibles acute, slightly curved and pointed in various directions). Sometimes only one avicularium and occasionally none, especially in the zoœcia towards the growing edge. On the dorsal aspect, the wall is thin, smooth, slightly convex and presents a rounded oval or reniform opening with a slightly raised border. Oœcia inapparent. Zoœcia about 0″·02 wide. Operculum 0″·012 × ·01.

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 49 fathoms, green mud.

[Gulf of Florida, 9 to 19 fathoms, Pourtalès.]

There appears no reason to distinguish this form from that described by Prof. Smitt, the only differences between them being that in the present the zoœcia in front are not so decidedly rectangular and that the number of avicularia is occasionally much greater, Prof. Smitt ascribing only one to his species, whilst in the present the number is very often four to each zoœcium. I have been unable to discern any oœcia in the Challenger specimens, and consequently no character derived from them is afforded. The double notching of the lower lip is a striking character possessed in common by the two forms, and as it is of extremely rare occurrence among the Polyzoa, must be held as of great importance, at any rate as a specific character.

(7) *Mucronella castanea*, n. sp. (Pl. XIX. fig. 6).

Character.—Zoarium flat, expanded. Zoœcia rhomboidal or subovate, wide, slightly convex in front; surface shining, uneven; wall punctured. Orifice coarctate; lower lip bluntly mucronate; peristome neither thickened, nor raised; usually an avicularium on one or both sides of the orifice in front, varying much in size, from 0″·005 to ·02 in length;

in the larger ones the mandible is acute, sword-shaped, pointing directly upwards; in the smaller, rounded. Œcium globose, very prominent, finely punctured all over, and sometimes, having at the lower part, in front, a rounded papillary eminence, supporting a minute avicularium. Dorsal wall entire. Zoœcia about 0″·02 wide. Orifice 0″·01 wide.

Habitat.—Off Bahia, 10 to 20 fathoms. Station 122, lat. 9° 5′ S., long. 34° 50′ W., 32 to 400 fathoms, red mud.

It is of a deep bright brown colour. The description is taken from specimens that have been boiled in caustic soda. In the natural state the surface is covered with a uniform chitinous epitheca, to which the colour is mainly due, and which conceals the sculpture of the surface. It occurs in the collection only in broken fragments which show no sign of its having been attached to anything. The posterior surface is smooth and divided into convex, oblong, imperforate spaces, corresponding to the outlines of the zoœcia.

In some respects closely resembling *Escharella lamellosa*, Smitt; the differences between that arctic form and the present are amply sufficient to distinguish them. Amongst these may be noted (1) that in *Escharella lamellosa* the wall of the zoœcium is entire and imperforate except a row of elongated punctures round the border, whilst in *Mucronella castanea* the surface is closely punctate all over; (2) in *Escharella lamellosa* there are normally 3 to 5 oral spines above, and the surface of the œcium is smooth, and presents three round pores in front, and usually an ovate stigma on each side below, whilst in *Mucronella castanea* the surface of the œcium is very finely and beautifully punctate all over, and is furnished with a small circular papilliform avicularium on each side below.

What the general habit of the zoarium may be cannot be determined from the fragmentary specimens in the collection.

(8) *Mucronella magnifica*, n. sp. (Pl. XVIII. fig. 3).

Character.—Zoarium expanded, suberect. Zoœcia subovate, or rhomboidal, or irregularly hexagonal behind; convex in front and behind; covered with a very thin dark brown epitheca. Anterior wall very thick, closely punctate; posterior thin, transversely wrinkled with from 1 to 4 or more rounded perforations, from which, in the upper part, radical tubes issue; four lateral interzoœcial plates. Orifice orbicular with a broad central mucro on the lower border and two lateral acute points (not internal denticles); four articulated marginal spines above. A conical, rostral projection in front, immediately below the orifice, supporting on one side of its summit an avicularium, with a broad duck-bill shaped mandible. On one or both sides of the orifice but not close to it is a large avicularium, with an elongated, duck-bill shaped mandible, pointing obliquely upwards. Œcium large, lofty, and very prominent, the front prolonged downwards

into a sort of lip overhanging the orifice. Surface very closely and finely punctured. Zoœcia about 0″·025 to ·03 wide. Orifice 0″·015. Operculum semicircular 0″·01 × ·008.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

From its size, colour, and conformation this form is one of the most magnificent of the Polyzoa. Although of such large dimensions, it is covered with an extremely thin and fugitive epitheca of a deep purplish-brown hue, (of a much deeper tint than that of *Mucronella castanea*), but the colour is in great part due to that of the polypides themselves. Amongst its most striking and conspicuous characters is the oœcium, of a beautiful pearly aspect and sculptured all over, except the lip-like prolongation inferiorly, and furnished with minute hexagonal pores. The marginal spines are represented, in the specimens observed, only by what appears to be the basal joint; they are probably when present of large size. From the figure it might be supposed that the lateral projections, at the lower part of the orifice, were internal articular denticles, but in reality they as well as the central broad mucro are, *ab origine*, processes of the thin peristome itself.

(*c*) Adnate (lepralian).

(9) *Mucronella* (*Phylactella* ?) *canalifera*, n. sp. (Pl. XXII. fig. 2).

Lepralia mangnevilla, Bk., Zoophyt., Quart. Journ. Micr. Sci., N. S., vol. xiii. p. 284, pl. xxxi. fig. 5 (*nec* Audouin).

Character.—Zoœcia erect, very distinct, ventricose, surface varnished and very finely punctate or frosted. Orifice suborbicular; peristome produced in front into a wide spout-like process; six long, tapering, oral spines above and on the sides. Oœcia small, recumbent, not punctured.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, sand.

[Madeira, J. Y. J].

This form differs from *Lepralia* (*Phylactella*) *labrosa* in the absence of an internal denticle, and from *Lepralia* (*Phylactella*) *collaris* in the presence of the oral spines and the absence of puncturation on the oœcium.

(10) *Mucronella tricuspis*, Hincks (Pl. XXII. fig. 3).

Mucronella tricuspis, Hincks, Ann. and Mag. Nat. Hist., ser. 5, vol. viii., 1881, p. 125, pl. iii. fig. 1.

Character.—Zoarium adnate. Zoœcia disposed quincuncially but more or less in linear series, running in different directions; deeply immersed, except at the growing edge, with the oral portion produced. Primary orifice transversely elliptical,

with a bluntly mucronate lower border; afterwards the peristome rises in front into a rather slender median mucro, usually with a shorter one on each side or sometimes two. Three or four non-articulated oral spines above. A projecting avicularium on one or both sides of the front low down, with an acutely pointed mandible pointing upwards and outwards; surface granular. Œcium rounded, subimmersed. Surface granular.

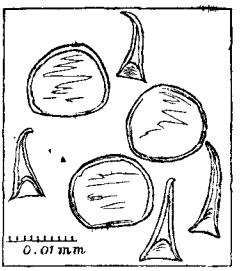


FIG. 45.—*Mucronella tricuspis.*

Habitat.—Station 315, lat. 51° 40′ S., long. 57° 50′ W., 12 fathoms, sand and gravel (on *Fucus*). Simon's Bay, Cape of Good Hope. Prince Edward Island, 80 to 150 fathoms.

[Tierra del Fuego and Chiloe Archipelago, Darwin; Curtis Island, Bass Strait, Hincks.]

On the Fuegian specimens the avicularia are sometimes much larger, but the mandibles present the same forked basal end.

The characters of *Mucronella tricuspis* are seen with great difficulty except at the growing border. The accompanying woodcut represents the chitinous organs, which are quite sufficient for its identification.

(11) *Mucronella simplicissima*, n. sp. ? (Pl. XXII. fig. 5).

Character.—Zoœcia very distinct, fusiform, subtubular, and curved forwards above; surface smooth, entire, porcellanous. Orifice orbicular, with a small pointed mucro in front; peristome very slightly thickened.

Habitat.—Station 161, off Port Philip, 33 fathoms; sand (on dead shells).

Probably merely an adnate variety of *Mucronella pyriformis.*

(12) *Mucronella ventricosa*, var. *multispinata*, Busk (Pl. XXII. fig. 11).

Lepralia multispinata, Bk., Quart. Journ. Micr. Sci., N. S., vol. i. p. 77, pl. xxxii. figs. 5, 6, 1861.
? *Mucronella peachii*, var. *β octodentata*, Hincks, Brit. Mar. Polyz., p. 361, pl. li. fig. 2.

Character.—Zoœcia ventricose, immersed below, convex in front and much raised, almost tubular above; surface granular, with a row of minute distant pores near the border. Orifice subclithridiate, mucronate in the young state; peristome in mature zoœcia thick, much raised and projecting in front, with six to eight erect, long, and strong spines on the sides and behind; but usually broken off. A broad denticle some distance within the orifice. Œcia prominent, small, globular; surface granular.

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms, hard ground, gravel and shells. Prince Edward Island, 80 to 150 fathoms.

The growth, which is of a most beautiful pearly aspect, completely covers the valve of a *Terebratula*, the zoœcia being disposed in parallel linear series, radiating irregularly from the centre.

The only difference of any importance between this form and the typical *Lepralia* (*Mucronella*) *ventricosa* is in its having eight oral spines instead of four. In this respect it corresponds with Mr. Hincks' *Lepralia* (*Mucronella*) *peachii* var. *β octodentata* with which indeed it is in all probability identical. But that it is a form of *Mucronella ventricosa* and not of *Mucronella peachii* is obvious from the other characters, amongst which perhaps the most important is the great width of the internal denticle. The great convexity also of the zoœcia and the deep sulci between them, together with the forward position of the oœcium and the peculiar radiate sculpturing of the surface of the zoœcia and their large size, seem to be sufficient to show that the present form should be referred to *Mucronella ventricosa*. One remarkable feature presented by it is the extreme diversity in size of the zoœcia; the central ones being perhaps less than half the size of those at some distance from the centre of the colony. It also exhibits in a very marked degree the great changes undergone at different stages by the peristome, which, in *Mucronella ventricosa*, as Dr. Manzoni remarks, "e tanto più largo et calloso, quanto più la cellula e avvanzata in età."

8. *Aspidostoma*, Hincks.

Eschara (sp.), Bk.

Character.—Zoarium dimorphous, uni- or bi-laminar; erect, solid, rising from a contracted calcareous base, or expanded and foliaceous. Zoœcia with the front depressed in the centre and the sides tumid. Mouth quite at the summit of the depressed area, concealed under the tumid border, on which above the mouth is a penthouse-like, usually bifid projection. The mouth arched above, straight below, and protected in front by a broad shield-like plate or mucro which is continued downwards for some distance within the zoœcium.

Aspidostoma giganteum, Busk, sp. (Pl. XXXIII. fig. 3).

Eschara gigantea, Bk., Brit. Mus. Cat., vol. i. p. 91, pl. cxix. fig. 3.
Aspidostoma crassum, Hincks, Contrib. Ann. and Mag. Nat. Hist., ser. 5, vol. vii. p. 47, pl. x. figs. 6, 6*a*, 1881.

Character.—Zoarium erect, bi- or uni-laminar. Zoœcia broadly pyriform or hexagonal, very convex or tumid in front, depressed in the centre. Surface granular, walls very thick and massive, rounded on the sides; separated by deep sulci. Mouth quite at the summit of the depressed area concealed under the tumid border, crescentic

or arched above, straight below, protected in front by a broad mucronate plate. Above the mouth a penthouse-like projection, usually bifid but sometimes continuous.

Habitat.—Station 135c, off Nightingale Island, Tristan da Cunha, 110 to 150 fathoms.

[South Patagonia, Darwin; between Patagonia and the Falkland Islands, Captain Warren, Hincks.]

I have followed Mr. Hincks in placing this very peculiar form under a distinct genus, quite agreeing with him that it is entitled to take that rank among the Escharidæ.

Mr. Hincks (*loc. cit.*) describes the zoarium as composed of two layers, and this was the condition in the form described by me in the Brit. Mus. Cat. under the name of *Eschara gigantea*; but the few fragments contained in the Challenger Collection exhibit only a single layer, and from the peculiar aspect of the dorsal surface it is obvious that when the layers are double, they are not inseparably united as in *Eschara*, but merely in apposition, so that in fact *Aspidostoma* should be regarded as belonging to the *Hemescharine* rather than to the *Escharine* type, or that the two layers are formed simply by reduplication of the lamina upon itself.

Mr. Hincks states that "leaning against the side of many of the cells, a little below the upper extremity, there is an avicularium, with a very short, broad, subtriangular mandible directed upwards"; and also that the "oœcia are elongate, much depressed, shield-like and granulated."

He also says that the broad shield-like plate in front of the mouth, or the "projecting lower lip" noticed in the Brit. Mus. Cat., is continued downwards for some distance within the cavity; and that attached to the inner surface of the plate, on a level with the margin of the orifice, is a semicircular membrano-calcareous frame into which the operculum fits.

§ 2. Primary mouth notched or sinuated below.

9. *Schizoporella*, Hincks.

Lepralia, (pars), Johnst., Busk, &c.
Escharina (pars), d'Orb.
Reptoporina (pars), d'Orb.
Escharella, subgenus *Hercatia* (pars), Smitt, Krit. Förteckn.
Mollia (pars), Smitt, *Ibid.*
Schizoporella, Hincks, Brit. Mar. Polyz.

Character.—Zoarium erect and bi- or uni-laminar; or crustaceous and unattached; or adnate. Lower lip with a median notch. Operculum pedunculate, or contracted below.

(*a*) Bilaminar (escharan).

(1) *Schizoporella furcata*, n. sp. (Pl. XXI. fig. 5).

Character.—Zoarium (small), furcate; branches subcylindrical, tapering (0″·05 to ·055 wide). Zoœcia immersed, oblong, separated by thin septa. Surface punctate. Mouth semicircular, with a wide shallow sinus in the lower lip. Sometimes, but rarely, a very small avicularium on one shoulder. Oœcia lofty, convex, and prominent in front, but deeply imbedded in the superjacent zoœcium; surface finely granular; with an arched line on either side, the two converging so as to form a slight keel on the front.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

There is sometimes a small membranous web filling up the angles of the branches of the zoarium.

(*b*) Unilaminar (hemescharan).

(2) *Schizoporella nivea*, n. sp. (Pl. XVII. fig. 1).

Character.—Zoarium expanded, foliaceous, free, of a milk-white colour. Zoœcia quincuncial, but serial; quadrangular, slightly convex in front and separated by fine septal ridges; surface uniformly punctured. Orifice suborbicular, slightly sinuated below. A small rounded papillary elevation at each upper angle, not apparently avicularian, but closed. Oœcium globose, large, punctured uniformly with the wall of the zoœcium. The dorsal surface of the zoœcia entire and smooth.

Zoœcia 0″·025; orifice 0″·0075 wide.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand.

(3) *Schizoporella longispinata*, n. sp. (Pl. XVII. fig. 2).

Character.—Zoarium small, partially attached by calcareous matter but mostly free. Zoœcia quincuncial, completely immersed, but convex in front, broadly ovate; at the growing margin subventricose. Surface irregularly verrucose. Orifice orbicular, emarginate, unchanging. Peristome rather thick, with six very long, acute, usually terete but sometimes compressed, articulated and jointed oral spines; sometimes bifid at the point. An erect, acutely pointed avicularium on one side of the orifice, with an acute slender mandible pointing directly upwards. Oœcium globose, smooth and polished, with a sinus or notch on each side at the bottom, the anterior border of its opening descending so as to completely conceal the opening, and the whole oœcium

stands behind and free of the zoœcial orifice. Two or sometimes four of the marginal spines persist in front of the oœcium. On the dorsal aspect the zoœcia are irregularly hexagonal and convex, with a small circular pore in the centre of each. Zoœcia about 0″·02 wide; orifice 0″·005.

Habitat.—Station 312, lat. 53° 37′ S., long. 70° 56′ W., 10 to 15 fathoms, blue mud.

The chief peculiarities of this form are:—1. The great length of the oral spines on the young zoœcia and the curious structure presented by some of them, which are more or less compressed, whilst the majority are cylindrical or terete; both appear to be indistinctly jointed, and many, instead of a single long and acute point, have a small terminal joint supporting two minute conical points. 2. Besides the central pore on the dorsal wall, many of the zoœcia present hollow conical elevations, by which, as it would seem, the very scanty calcareous adhesions are formed.

(4) *Schizoporella auriculata* (?), Hassall, var. *alba*, nov. (Pl. XIX. fig. 1).

Character.—Zoarium delicate, thin, white; zoœcia rhomboid or subovate, deeply immersed, no septa; disposed in lines radiating from the centre. Surface vitreous, granular, very obscurely punctured round the border. Orifice orbicular, emarginate, with four superior marginal spines. A prominent conical rostrum immediately below the orifice, with a circular avicularium on the summit. Oœcia about half immersed, lofty, convex in the front which presents a circular circumscribed area including numerous punctures of unequal size and more or less angular in shape.

Habitat.—Station 135c, off Nightingale Island, 110 to 150 fathoms, and (135a) off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel.

Probably closely allied to *Schizoporella auriculata*, but differing in the absence of any raised septal line between the zoœcia, and it may be added in the white colour, and more particularly also in the shape of the operculum.

(5) *Schizoporella jacksoniensis*, n. sp. (Pl. XIX. fig. 3).

Character.—Zoarium rather thick. Zoœcia broadly ovate, very convex, with a distinct raised line round the border. Surface reticulato-punctate. Orifice emarginate, peristome thickened, smooth, slightly raised above (not in front). A rather large sessile avicularium on one side of many of the zoœcia with an acute triangular mandible, directed upwards. Oœcia inapparent.

Habitat.—Station 163b, off Port Jackson, 35 fathoms, hard ground (parasitic round a Sertularian).

(6) *Schizoporella tenuis*, n. sp. (Pl. XX. fig. 10).

Character.—Zoarium very delicate, expanded, unattached. Zoœcia quadrangular, flattened or depressed in front, separated by thin raised septal ridges; surface punctate. Mouth orbicular, with a wide shallow sinus in front, and on the sides a minute articular notch. Peristome thin, slightly raised in front. A minute round or oval, quite immersed avicularium at each intersection of the vertical and transverse interzoœcial septa. Oœcia 0?

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms. Simon's Bay, Cape of Good Hope.

At first sight bearing a general resemblance to many of the various Lepralioid forms, known as *Lepralia* (*Schizoporella*, Hincks) *unicornis*, *ansata*, &c., the present species appears to be distinguished (1) by the perfectly flat or concave anterior surface of the cells; (2) by the form of the mouth, which, instead of being semicircular with an emarginate lower lip, is more of the rounded clithridiate form, assigned by Prof. Smitt to his hippothoan species; (3) by the circumstance that the lateral avicularia are placed quite in the angles formed by the transverse and longitudinal interzoœcial septa, and that they are of much smaller size or more deeply immersed than in any of the forms placed under *Lepralia unicornis* or *Lepralia ansata*, and have a semicircular, extremely minute mandible. With respect to these avicularia, it may be mentioned that they are fully formed, as it would seem, before the completion of the zoœcia themselves, as may be seen at the growing edge, so that they might perhaps be described as belonging more to the general zoarial whole than to any particular zoœcial compartment of it.

(*c*) Adnate (lepralian).

(7) *Schizoporella elegans*, d'Orbigny (Pl. XXII. fig. 8).

? *Escharina elegans*, d'Orb; Voy. en Amér. Mérid.

? *Lepralia squamoidea*, Reuss, Oberoligocäns, p. 19, pl. xv. fig. 5, and Bryoz. des Sept. p. 56, pl. vii. fig. 3; Manzoni, Castracaro, p. 29, pl. iv. fig. 46.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand (parasitic on an *Adeonella*). Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 500 fathoms, hard ground, gravel and shells.

(8) *Schizoporella marsupifera*, n. sp. (Pl. XXII. fig. 14).

Character.—Zoœcia irregularly hexagonal, slightly convex in front; surface pearly, glistening, very finely granular; disposed quincuncially and separated by raised septa. Orifice orbicular, emarginate, peristome thin, furnished very rarely with two long oral

spines behind. A prominent rostral pouch, supporting a small avicularium on the front of the zoœcium below the orifice. Oœcia very prominent, globose, rather wider than high; surface granular with a faintly marked, beaded border.

Habitat.—Marion Island, 50 to 75 fathoms (on *Fucus*). Station 167, lat. 39° 32′ S., long. 171° 48′ E., 150 fathoms, blue mud.

The oral spines remain, apparently, only on the youngest zoœcia at the growing edge of the colony.

(9) *Schizoporella cecilii*, Audouin (sp.).

Flustra cecilii, Aud., Expl. i. p. 239; Savigny, Egypte, pl. viii. fig. 3.
Lepralia cecilii, Bk., Quart. Journ. Micr. Soc., vol. v. p. 173, pl. xv. figs. 6, 7; Macgillivray.
Schizoporella cecilii, Hincks, Brit. Mar. Polyz., p. 269.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand.

(10) *Schizoporella circinata*, Macgillivray (sp.).

Lepralia circinata, Macgilliv., Nat. Hist. Vict. Dec. iv., p. 21, pl. xxxv. fig. 1.

Character.—Zoarium adnate (on coral). Zoœcia broad, ovate, convex in front, no interzoœcial septa. Surface in the middle prominent, quite smooth, outside of which it is widely punctate or pitted. Oral orifice semicircular, with a perfectly straight lower border with a median narrow notch or fissure which widens out below and lodges a moveable process connected with the operculum; 6 to 8 long articulated oral spines above. Oœcium lofty, prominent, glassy, smooth. Sometimes a long channel-like retentive avicularium on the front, the mandible pointing downwards.

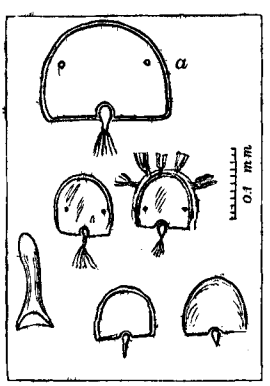


FIG. 46.—*Schizoporella circinata.*
a, Operculum of Schizoporella cecilii.

Habitat.—Station 135A, off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel.

The very peculiar conformation of the operculum in this species, exactly resembling that of *Schizoporella cecilii* in miniature, affords at once a distinctive character, as I am unacquainted with any other form with a similar kind of operculum. What is the nature of the curious little moveable appendage jointed to the operculum, in this and the preceding species, is by no means clear; but it would seem that a minute fasciculus of muscular fibres is connected with its lower part. The accompanying woodcut shows the characters above described, as well as the great difference in size of the operculum (*a*) of *Schizoporella cecilii*.

(11) *Schizoporella triangula*, Hincks.

Schizoporella triangula, Hincks, Contrib. vi., Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 12, pl. ii. figs. 4, 4*a*, 1881.

Character.—Zoarium adnate or partially free (on sponge), sometimes with superposed layers. Zoœcia disposed irregularly or in linear series and separated by raised septa; subquadrangular or irregular in outline; surface nodulose (sometimes reticulato-punctate); of two kinds, barren and fertile or oœcial. Orifice of barren cells subtriangular, arched above and much contracted or pointed below, with a small articular denticle on each side near the bottom; of the fertile or oœcial cells, much larger, elongated transversely and arched above, with a slightly sinuated entire lower border. A small avicularium with an acute triangular mandible close to the orifice; and on the front a vertical elongated avicularium with a slender spear-shaped mandible slightly dilated at the point, upon which is a minute obtuse mucro. Opercula of two kinds corresponding to the two forms of orifice, both thick and solid, and marked with fine curved transverse wrinkles.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells. (?) Station 151, off Heard Island, 75 fathoms, volcanic mud.

[Bass Strait, 40 fathoms; common, Hincks.]

In the quite young state the surface appears to be reticulato-punctate, but generally it is closely nodulose. The nodules, more especially in the fertile or oœcial cells, are often developed into large verrucose elevations which sometimes project over the oœcial orifice so as almost to conceal it. The triangular operculum of the barren cells closely resembles that of *Lepralia arrogata*, Waters, from the Mediterranean, but in that form there is but one kind of operculum, which moreover does not present the transverse rugæ visible in that of *Schizoporella triangula*.

10. *Gephyrophora*, n. gen.

Character.—Zoarium dimorphous, either erect and irregularly branched, and cylindrical with the zoœcia disposed round an imaginary axis, or decurrent, loosely encrusting, and unilaminar. Zoœcia completely immersed, flat in front, parted by septal ridges. Surface beneath the epitheca finely reticulate. Primary orifice arcuate, with the lower border slightly sinuated, afterwards transversely oblong. A prominent avicularian process on each side of the orifice, the two eventually inarching and forming a bridge in front of it.

(1) *Gephyrophora polymorpha*, n. sp. (Pl. XXXIV. fig. 2).

The only species.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand.

[S. Africa, Mrs. Gatty.]

The zoarium appears to be dimorphous, or rather polymorphous, as it sometimes encrusts foreign bodies, in a single unattached layer. But even in its independent erect form, or more complete condition, as it may be termed, it is extremely variable in habit. Sometimes it presents long cylindrical distant branches, and sometimes assumes the form of stunted tufts or short branches, or even little more than irregular nodulated masses.

On a transverse section the interior of a branch exhibits no central axis nor interlaminar expansion. The interzoœcial walls are extremely delicate and closely perforated in all parts.

In the dried condition the cavity of each zoœcium is seen to be divided into two compartments, an anterior and a posterior, by a vertical diaphragm formed of an extremely delicate membrane. The hinder compartment, which in the dry state is very much the larger, lodges the polypide and communicates directly with the oral orifice, whilst the anterior, which probably exists as a chamber only in the dry state, being merely the space between the vertical diaphragm and the anterior calcareous wall, in the ordinary zoœcia does not appear to contain anything, but in others it is into this space that the subjacent oœcium intrudes, and may often be seen in the form of a spherical vesicle containing a vitelline mass or embryo. As a similar arrangement exists in *Siphonicytara* it is not improbable that this division of the zoœcial cavity into two compartments by a flexible membranous diaphragm will be found pretty generally in all zoœcia of which the wall is wholly rigid, and that it is intended for the purpose of allowing the compression of the perigastric cavity necessary to effect the protrusion of the polypide, which would otherwise seem to be scarcely possible in a perfectly unyielding box.

11. *Myriozoum*, Donati.

Myriozoum, Donati, 1750, d'Orb., Smitt (pars).
Millepora (pars), Pallas, 1766, Solander, Strom, Fabricius.
Myriapora, Blainv., 1834.
? *Foricala* (pars), d'Orb.
Cellepora (pars), *Leieschara*, Sars.
Gemellipora (sp.), Smitt.

Character.—Zoarium erect, branched, continuous; branches cylindrical, obtuse; or oviform. Surface punctured or reticulate. Avicularia, when present, immersed and usually placed near the orifice, either above, below, or on one or both sides. Orifice notched or sinuate, or canaliculate below.

The transition from the typical form of *Myriozoum* as exhibited in the well known *Myriozoum truncatum* to other cylindrical escharine growths, is so gradual that it is in

fact difficult to draw any definite line between them. In the sense in which the name is here employed, it is extended to embrace continuous zoaria, usually composed of cylindrical branches, for the most part of uniform diameter throughout, and in the more typical species obtusely rounded at the ends, towards which alone the orifices remain patent, the lower parts becoming more or less solidified and sometimes presenting no trace of the zoœcial structure either externally or internally.[1] In the less typical forms this condition does not attain to anything like the same extent, but in all there is a very great tendency to the obliteration of the zoœcia in the older parts.

Another circumstance in which the true or typical species of *Myriozoum* are distinguished from the rest, is the finely cancellated structure of the walls of the cells, or as it may be stated, of the entire substance in the actively growing parts. On the exterior this is indicated by the close reticulation, as it may be termed, rather than punctuation of the surface, whilst internally the walls of the zoœcia are generally very thick and finely cancellated, so that ample provision is made for the ready diffusion of fluid throughout the growth; which may not improbably be connected with the abundant deposit of calcareous matter in the older portions of the zoarium.

These differences in essential structure appear to be of sufficient importance to justify, if not the entire separation generically of the typical forms from others here included in the genus, at any rate the placing of them in a distinct section, as follows:—

§ 1. *Myriozoa typica.*

(1) *Myriozoum truncatum*, Donati.
(2) *Myriozoum subgracile*, d'Orbigny.
(3) *Myriozoum coarctatum* (Sars).

§ 2. *Myriozoa dubia.*

(1) *Myriozoum honolulense*, n. sp.
(2) *Myriozoum immersum*, n. sp.
(3) *Myriozoum simplex*, n. sp.
(4) *Myriozoum marionense*, n. sp.

All the forms in the Challenger Collection belong to the second division.

[1] When a portion of the completely solidified part of *Myriozoum truncatum* is decalcified, the chitinous opercula and shrunken remains of the endocyst may often be found enclosed in the interior.

(1) *Myriozoum honolulense*, n. sp. (Pl. XXV. fig. 2).

Character.—Zoarium about 0″·75 high, simply branched in all directions, rising from an encrusting base. Zoœcia rhomboidal, flat, with faint wavy septal ridges. Orifice orbicular, sinuated, perfectly even with the surface, lower lip slightly raised or tuberculated. Surface punctured. Small circular, scattered, immersed avicularia.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

From the single small specimen this would seem to be a dimorphic form, that is to say, the base sometimes expands into a single hemescharine layer.

(2) *Myriozoum immersum*, n. sp. (Pl. XXV. fig. 4).

Character.—Zoarium with divergent, furcate ramifications, branches about 0″·125 in diameter. Zoœcia completely immersed, so that their outline is quite obscured; surface finely wrinkled longitudinally; orifice (primary) very deeply immersed at the bottom of a deep pit, on the sides of which are usually one or more very minute immersed avicularia with a pointed triangular mandible; the primary orifice itself is probably of an inverted horse-shoe shape. A very few scattered papillary eminences formed by the projection of the upper border of the oral pit in a cucullate form, each of which has a small avicularium on the under side (fig. 4*a*).

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

In this case it is very difficult to make out the true form of the primary orifice, owing to the depth at which it is placed, even in the youngest zoœcia. In general, however, the secondary ? orifice has the form above mentioned, with one or more irregular internal projections. In the zoœcia which project in the form of conical papillæ the primary mouth would seem to be Myriozoan in character; the situation of the lower border is, however, very slight. The systematic position of the species is very doubtful.

(3) *Myriozoum simplex*, n. sp. (Pl. XXV. fig. 1).

Character.—Zoarium composed of slender cylindrical, dichotomous branches. Zoœcia at the growing extremities subventricose, distinct, in the older parts completely immersed and indistinct. Peristome in the younger cells raised, tubular, canaliculate or deeply emarginate in front; in the older cells forming merely a rounded eminence, with an apparently circular emarginate orifice. Surface rough, sparsely punctured; in the older portions smooth and shining. Oœcia ? deeply immersed. Avicularia 0.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

The proper generic position of this species is also extremely doubtful. The tubular peristome in the youngest zoœcia suggests an affinity with *Tessaradoma*, but there is no median pore, and the mouth is apparently that of a Myriozoan, although if the primary mouth could be seen it would probably be found to correspond in form with the very delicate operculum, which I have succeeded in isolating, and found to be semicircular with a straight entire lower border. The solid texture of the cell walls which are obscurely punctate, and the entire absence of any avicularian organs, are strongly against placing it with the typical *Myriozoa*. I do not however venture to make a new genus for its reception, and have therefore provisionally placed it under *Myriozoum*.

(4) *Myriozoum marionense*, n. sp. (Pl. XXIII. fig. 6).

Character.—Zoarium continuous, composed of long straggling cylindrical branches of uniform diameter, divaricating irregularly usually at right angles, occasionally anastomosing and constricted at irregular intervals. Surface in the natural state polished and covered with a plumbeous-coloured thick epitheca, beneath which it is punctate with elongated pores. Zoœcia completely immersed, with no visible outlines, disposed quincuncially on all sides of the branches. Orifice completely immersed, looking directly upwards, transversely elliptical anterior border thin, entire. A small avicularium with a spatulate mandible on each side just within the border of the orifice. No visible operculum. Oœcia 0.

Habitat.—Prince Edward Island, 80 to 150 fathoms. Station 151, off Heard Island, 75 fathoms, volcanic mud. Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 to 500 fathoms, hard ground, gravel and shells. Off Marion Island, 50 to 75 fathoms.

I place this very peculiar form under *Myriozoum* chiefly on account of its external habit which is exactly like that of that genus, especially as shown in *Myriozoum coarctatum*. But in other and more essential characters it differs so widely from the typical forms of the genus that its collocation with them must be regarded as entirely artificial.

The collection affords abundance of specimens in perfect preservation, but notwithstanding numerous attempts at decalcification I have been unable to detect a trace of an operculum, which I thence conclude must either be entirely membranous and very delicate, or perhaps wholly deficient.

12. *Haswellia*, n. gen.

Myriozoum, sp., Haswell.

Character.—Zoarium composed of short cylindrical branches, spreading in all directions dichotomously, at very open angles. Zoœcia disposed verticillately and more or less irregularly quincuncial, with a produced tubular or subtubular and bifid, or simply

thickened peristome, supporting on each side a small avicularium with a pointed subtriangular mandible. Primary mouth clithridiate with an operculum of corresponding form.

In a paper on some Polyzoa from the Queensland Coast, Mr. W. A. Haswell describes a species referred by him to the genus *Myriozoum*, with the specific name *australiense*. Before this paper came under my notice I had already described and prepared figures of the same species in the Challenger Collection and named it *Tessaradoma verticillatum*, which specific name of course must yield to Mr. Haswell's appellation, and as it appeared to me on further examination that the form could not be included under *Tessaradoma*, notwithstanding the presence of a suboral pore, I had like Mr. Haswell subsequently referred it to *Myriozoum*. But I have since come to the conclusion that notwithstanding certain points of resemblance it would be forcing the relation much too far to join it to the group of which the well known *Myriozoum truncatum* is the type. I have consequently thought that it might form the foundation of a distinct generic group, as another member of which I would add with much doubt a second species in the present collection, *Haswellia auriculata*, which, as in the case of *Haswellia australiensis*, I had originally referred to *Tessaradoma* and afterwards to *Myriozoum*.

(1) *Haswellia australiensis*, Haswell (sp.) (Pl. XXIV. fig. 9).

Myriozoum australiense, Haswell, Proc. Linn. Soc., N. S. Wales, vol. v. pt. 1, p. 33, pls. i.–iii. 1880.

Character.—Zoarium composed of short branches diverging dichotomously at wide angles and each containing four to five whorls of cells, each whorl composed of from six to eight or ten cells. Zoœcia completely immersed so that no outline is visible except the much produced tubular peristome, the anterior lip of which (when perfect) is trifid, each lateral tooth supporting a small avicularium with a subtriangular pointed mandible; the posterior lip finely crenulate. Primary mouth at bottom of tubular portion clithridiate, bidenticulate, and closed with a strong chitinous operculum of corresponding form and about 0″·007 × ·005 in size. In front of the tubular portion a rather large rounded pore formed at the bottom of a median fissure. Surface uniformly pitted or reticulato-punctate. Minute immersed avicularia with an acicular mandible pointing downwards, in the sulci between the zoœcia.

Habitat.—Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud. Station 190, lat. 8° 56′ S., long. 136° 5′ E., 49 fathoms, green mud.

At first sight the tubular production of the peristome with the pore on its front presents a very strong resemblance to *Tessaradoma*, but the pore is of a totally different

nature. It has no communication with the body of the cell, as in that genus, nor has it the same tubular character, and its original mode of formation is apparently quite different. It belongs to what might be termed the simply suboral pores, whose function like that of the other special pores at present is altogether conjectural, but may be anal.

In the older or lower portions of the growth the peristomal tube becomes shorter and thicker and for the most part so mutilated as to present no trace of the trifid division of the anterior lip, the middle tooth of which however remains more or less distinct and is sometimes produced into a downwardly curved sort of beak.

(2) *Haswellia auriculata*, n. sp. (Pl. XXIV. fig. 10).

Character.—Zoarium about 0″·75 to 1″ high, composed of short forked branches. Zoœcia irregularly verticillate, about six in each whorl and usually in pairs; when young ovate slightly convex, when old completely immersed. A marginal row of distinct puncta round the border. Primary orifice horizontal, orbiculo-emarginate with a thin pointed process of the peristome on each side, supporting minute avicularia with an acute triangular mandible pointing upwards, the peristome afterwards becoming more or less tubular with a deep notch and sometimes a suboral pore in front. Oœcia numerous, with a circular area in front surrounded by a narrow raised fillet.

Habitat.—Station 135c, off Nightingale Island, 110 to 150 fathoms, and (135a) off Inaccessible Island, Tristan da Cunha, 75 to 90 fathoms, hard ground, shells, gravel. Station 142, lat. 35° 4′ S., long 18° 37′ E., 150 fathoms, green sand.

It is with some hesitation that I conjoin this species with the preceding, but as it seems to present more points of resemblance with *Haswellia australiensis* than with any other form with which I am acquainted, it seems convenient to do so provisionally at any rate rather than give it a separate generic appellation.

The younger zoœcia are quite distinct, with a subtubular orifice at first presenting a thin lamina on each side, which as they grow together more or less completely form an imperfectly tubular peristome, with a deep notch in front which sometimes eventually becomes a suboral pore, as in *Haswellia australiensis*, but which as in that species cannot be regarded as homologous with the median pore of *Tessaradoma*, &c. The row of marginal puncta is a feature also in common with *Tessaradoma*. But the difference in the present species, in this respect, between the older and younger portions of the zoarium is very great; also owing to the great thickening of the walls and the consequent deep immersion of the mouth, the lateral avicularia are deeply placed and may easily be overlooked. The oœcia in *Haswellia auriculata* are remarkable for their great number, almost all the cells in some specimens being crowned by one. In the younger unthickened parts these organs are subglobose and rather prominent, but they soon become more or

less immersed and in the oldest parts of the zoarium their site is indicated merely by a small circular pit close above the oral opening; this is owing to the circumstance that the central circular perforated area on their front is apparently never completely calcified.

13. *Tessaradoma*, Norman.

Pustulipora (pars), Sars.
Quadricellaria, Sars, Alder.
Onchopora (pars), Bk.
Anarthropora, Smitt.
Tessaradoma, Norman, Smitt.
Eschara (pars), Auctt.
Porina (pars), Hincks, *nec* d'Orb.

Character.—Zoarium continuous, erect, ramose, arising from a calcareous base, or by radical tubes. Stem and branches cylindrical. Zoœcia tubular above from production of the peristome A median circular pore usually with a raised shortly tubular border on the front. With or without immersed avicularia, and marginal pores.

I have preferred to retain Dr. Norman's appellation for this genus instead of *Porina* which has been adopted by Mr. Hincks (Brit. Mar. Polyz., p. 227), simply as it would seem for the reason that he considers it to be identical with the *Porina* of M. d'Orbigny. But as that author's Family Porinidæ has expressly for one of its characters "cellules entières, juxtaposées sur deux plans opposés sur un seul plan libre ou fixe" and gives as one of the characters of *Porina* "rameaux comprimés," and the cells "adossées les unes aux autres latéralement;" and as having neither "cellules accessoires ni vésicules ovariennes," and moreover cites two living species as belonging to it—*Porina africana* and *Porina* (*Eschara*) *gracilis*, Lamarck, neither of which, so far as I can perceive, has any character in common with *Tessaradoma*, I see no reason to follow him. Besides this, as the term *Porina* has been used by Prof. Smitt in another sense, it will I think obviate much confusion if Dr. Norman's name be retained.

Tessaradoma boreale, Busk (sp.) (Pl. XXIV. fig. 8).

Pustulipora gracilis, Sars, Reise i Löf. og Finnm. p. 26.
Quadricellaria gracilis, Sars, Norske Polyzoer, p. 15; Alder Quart. Journ. Micr. Sci., N. S., vol. iv. p. 101, pl. ii. figs. 9–12.
Onchopora borealis, Bk., *Ibid.*, vol. viii. p. 243, pl. xxviii. figs. 6–7.
Anarthropora borealis, Smitt, Kritisk Förteckn., pp. 8, 67, pl. xxiv. figs. 25–29.
Tessaradoma gracile, Norman, Brit. Ass. Rep., 1868, p. 309.
Tessaradoma boreale, Smitt, Florid. Bryoz., pt. 2, p. 32, pl. vi. figs. 143–145.
Porina borealis, Hincks, Brit. Mar. Polyz. vol. i. p. 229, pl. xxxi. figs. 4–6.

Character.—Zoarium one to two inches high or more, irregularly dichotomous. Branches cylindrical, subterete. Zoœcia usually quadriserial, alternate, subventricose;

parted by thin raised septal lines; surface longitudinally wrinkled; a row of distant pores near the border and a few others sparsely scattered on the front. Peristome tubular, curved forwards nearly at a right angle. Median pore usually subtubular, sometimes depressed, immediately below the peristome. Avicularia small, circular; slightly raised, sparsely disposed on the front and sides of the zoœcia. "Oœcia terminal, slightly raised, transversely elliptical, with a striated surface," Hincks.

Habitat.—Station 23, off Sombrero Island, North Atlantic, 450 fathoms, Pteropod ooze. Station 13, lat. 21° 38′ N., long. 44° 39′ W., 1900 fathoms, globigerina ooze.

[Norway, Finmark, between Norway and Spitzbergen—lat. 77° 5′ N., long. 10° 3′ E., 600 fathoms—Chydenius; Gulf of Florida, very abundant, Pourtalès; off the coast of Portugal and the Azores, Smitt; Shetland, Barlee].

In habit of growth this species varies a good deal, and according to Prof. Smitt it would appear to be more or less dimorphous, occurring in a lepralioid or alysidotal form, but of this no indication is afforded in the specimens that have come under my notice. And if one may be allowed to judge simply from Prof. Smitt's figures, I should be much inclined to doubt, with the greatest deference to him, whether his figures (*loc. cit.*) fig. 143, and the two lowermost zoœcia in fig. 144, really form part of the *Tessaradoma* at all, or have merely become accidentally associated with it. The latter figure at any rate might well be regarded as *Lepralia* (*Porina*) *ciliata*.

With respect to the median pore, one of the Challenger specimens presents an appearance which may perhaps afford some indication of the function of the opening in this situation. In this instance the slender tube (fig. 8*e*) rising from the pore is quite perfect, and slightly dilated at the end; through this short tube a cylindrical chitinous rod or tubule of a dark brown colour protrudes, upon the extremity of which is firmly affixed a small *Rotalina*. From this it would seem allowable to surmise that in some cases the so-called median or central pore may serve for the emission of a prehensile organ, capable of attaching itself to foreign bodies, and thus performing what may be supposed to be the function of an ordinary avicularium. But there can be no doubt, as I have observed above, that the nature and true homologies of these median pores are very various, and for the most part at present wholly unknown.

I have not as yet been able myself to perceive the primary mouth in *Tessaradoma boreale*, but from Prof. Smitt's figure (*loc. cit.*, pl. xxiv. fig. 29), it would appear to be circular, with a central opening through a hymen-like membrane—a very curious condition if it be correctly figured. The very delicate operculum, however, is circular with a thin chitinous thickening on each side and it is not perforated.

14. *Gemellipora*, Smitt.

Gemellipora (pars), Smitt, Florid. Bryoz., p. 37.

Character.—Zoarium erect and ramose, or crustaceous and adnate. Mouth elongate pyriform with an articular notch on each side below. Operculum of corresponding pyriform shape. A median immersed avicularium; either above or below the mouth.

(*a*) Erect and ramose (escharan).

(1) *Gemellipora glabra*, Smitt (Pl. XXV. fig. 3).

Gemellipora glabra (*forma typica*), Smitt, *loc. cit.*, p. 37, pl. xi. figs. 208–210.

Character.—Zoarium erect, cylindrical, irregularly branched. An orbicular immersed avicularium above most of the orifices; four or five curved rigid oral spines above.

Habitat.—Off Bahia, 10 to 20 fathoms, mud.

[Gulf of Florida, 36 to 42 fathoms, Pourtalès; John Adams' Bank, H.M.S. "Herald."]

In the older parts the zoœcia are completely immersed at the oral end, presenting only a slight tubercular projection surrounding a deep circular pit, within which the primary orifice is scarcely discernible. At the same time the supra-oral avicularium becomes either entirely obliterated, or is represented merely by a small pit.

I have retained Prof. Smitt's generic name, being reluctant unnecessarily to create a new one, although the appellation which was doubtless suggested by the habit of the zoarium in *Pasythea eburnea*, is no longer appropriate. Reluctant as I am to differ from Prof. Smitt, where it is possible to agree with him, I must confess that the generic and specific characters of *Pasythea* (*Gemellipora*) *eburnea*, and of *Gemellipora glabra* and *Gemellipora striatula* appear to me such as to render it impossible to associate them even remotely. Leaving out of consideration the other numerous points of difference, there is no resemblance even in the shape of the orifice upon which perhaps undue importance in many cases has been placed.

In the few fragmentary specimens afforded by the Challenger Collection I have failed to perceive any of the larger avicularia on the front of the cells noticed by Prof. Smitt. The peculiar curvature of the oral spines is well shown in his figure.

(*b*) Adnate (lepralian).

(2) *Gemellipora cribritheca*, n. sp. (Pl. XXXIII. fig. 5).

Character.—Zoœcia completely immersed, with very indistinct outline, surface closely punctate; flattened in front. Peristome very thin and quite level with the surface. A

small median suborbicular immersed, oral avicularium. Œcia flattened in front with a depressed circular cribriform area.

Habitat.—Simon's Bay, Cape of Good Hope (on a *Membranipora*).

A second lepralian species of the genus, constituted as above, is the *Gemellipora striatula*, Smitt (*loc. cit.*, pl. xi. fig. 207), in which there is apparently a small median avicularium ? above instead of below the orifice.

Family XXI. ADEONEÆ, n. fam.

Escharidæ (pars), Auctt.

Character.—Zoarium erect or (rarely) encrusting, affixed either by a more or less flexible jointed or unjointed, radicate, chitino-calcareous peduncle, or immediately attached to some flexible body, either with or without a contracted base. Bilaminar except when encrusting; foliaceous, expanded and fenestrate; or branched or lobate and entire. Cells of two or usually three kinds, zoœcial, oœcial, avicularian. No oœcia of the usual type. On the front a median pore, usually simple and circular, sometimes irregularly fimbriate, or represented by a depressed perforated areola. Usually one or more sessile avicularia on the front. In the oœcial cells the pore in most cases is suboral, or placed immediately below the mouth, and usually a minute avicularium on each side. The wall of the zoœcial cells is punctate or entire, that of the oœcial always punctate.

The forms included in the group above indicated appear to constitute a natural and well marked assemblage, distinguished, notwithstanding a considerable diversity of habit, by very peculiar characters. Amongst these may be briefly noticed:

1. The existence of three distinct forms of cells.

2. The entire absence of oœcia of the usual type, whose function appears to be discharged by special cells, usually marginal but sometimes interspersed amongst the others, from which they differ in size and form, as well as in other more important respects. They are, in the first place, usually larger, and are always more or less convex, instead of depressed in front, and their wall, whatever may be its condition in the barren or zoœcial cells, is always thickly punctate, as if to afford greater facility for the aeration of their contents. In the oœcial cells also the median pore is always placed close below the orifice,[1] and is always formed originally by the upgrowth and eventual coalescence of two tubercular elevations, one on either side, by which a sort of preoral bridge of two arches is sometimes formed, beneath which is the median pore, and on the sides or lateral piers of the bridge is usually placed a minute avicularium.

When decalcified the oœcial cell appears in the form of a thick walled sac, occupied by an ovoid finely granular mass resembling the contents of an ordinary oœcium. But

[1] *Adeona pectinata* is an exception in this respect.

in one or two instances I have noticed, instead of the ovoid, probably embryonic mass, the remains of a polypide with tentacles and digestive organs like those of the inhabitants of the zoœcial cells, whence we may suppose that the embryonic mass is developed from or in a polypide, which is gradually replaced by it.

3. The presence of a median pore or its equivalent, which though not formed or developed in the same way in all the Adeoneæ, doubtless subserves the same function in all, and in every case appears to me to differ widely in nature from the lunate pore in *Onchopora*, *Microporella*, &c., as well as from the tubular pores in *Tessaradoma*, *Tubucellaria*, &c.

In the Adeoneæ, the pore seems to be formed in at least three distinct ways. The most common perhaps is by the constriction off of the lower part of the orifice, which in such cases is more or less deeply emarginate or sinuated. But sometimes it appears to arise from an arrest of calcification of the front, independently of the orifice altogether, whilst in other cases it is represented by what may be termed a "perforated area," that is to say, a depressed area or space, the bottom of which, formed by a thin calcified lamina, is pierced by from one to six or eight small circular fimbriated porules, the whole bearing some resemblance, if not some homological relation, to an interzoœcial plate, or so termed "Rosettenplatte." Besides this pore the front of the zoœcial cells and sometimes of the oœcial also, is furnished with one or more sessile avicularia.

4. In several species, if not in all, besides the oœcial and zoœcial cells, others may be seen, usually on the extreme border of the lobes, branches or fenestræ, though sometimes interspersed, which may be termed avicularian cells, that is to say, which are wholly converted into "vicarious" avicularia, whose large mandibles often afford very useful specific characters.

5. To these more important characters may be added one which though minute is so constant as to deserve especial notice. It consists in the circumstance that in the entire group the avicularian mandibles both large and small always exhibit a projecting point or articular process at each end of the base, into or close to which the erector muscles are attached. To which may be added that so far as I have noticed the occlusor muscle of the mandible is always single instead of consisting of two bands as usual.

In doubtful fragments the above character of the mandibles will alone often be found useful as an indication of the affinities of the species.

Though the division is to a certain extent arbitrary, I propose to divide the Family into two or three groups, which may provisionally at any rate be regarded as of generic value.

These are :—

1. *Adeona*, Lamouroux.
2. *Adeonella*, n. gen.
3. *Reptadeonella*, n. gen.

the last including such forms as *Lepralia violacea*, which in all essential characters is an Adeonean ; and perhaps *Lepralia innominata*, and several fossil forms.

The number of species belonging to the Family in the Challenger Collection does not exceed seven or eight and includes only one typical *Adeona*. But the number of forms referrible to it leaving aside those whose identification is impossible from the imperfect descriptions published, and most of which have come under my own inspection, is very considerable, as will appear from the subjoined probably very incomplete list.

In his Monograph of the Genus *Adeona* Dr. Kirchenpauer[1] enumerates about eight forms which he regards as species, viz :—

(1) *Adeona foliacea* or *foliifera*, Lamx. and Lamk.
(2) *Adeona intermedia*, Kirchenpauer.
(3) *Adeona macrothyris*, Kirchenpauer.
(4) *Adeona arborescens*, Kirchenpauer.
(5) *Adeona grisea*, Lamouroux.
(6) *Adeona cellulosa*, Macgillivray.
(7) *Adeona albida*, Kirchenpauer.

To which have been since added :—

(8) *Adeona wilsoni*, Macgillivray.

Besides these published species I am acquainted from direct observation with five or six others that I have not been able to identify with any of the foregoing, and which will be included in a projected memoir on the genus which I hope to be able shortly to prepare.

(9) *Adeona appendiculata*, n. sp., Australia.
(10) *Adeona gattyæ*, n. sp., South Africa.
(11) *Adeona lancifera*, n. sp., Australia ?
(12) *Adeona valga*, n. sp., Australia.
(13) *Adeona microthyris*, n. sp., Australia.
(14) *Adeona lycopodioides*, n. sp., South Atlantic.

Of these a single specimen of the first only occurs in the Challenger Collection, and is here described. For the second I have long been indebted to the kindness of Miss Gatty, to whom I also owe several species of *Adeonella*.

Adeona valga and *Adeona lycopodioides* have been for many years in my collection, whilst *Adeona microthyris* appears to me to be a new species contained in a magnificent collection of Australian Adeoneæ, lately sent by Mr J. Bracebridge Wilson to the British Museum.

[1] Dr. Kirchenpauer, Ueber die Bryoz. Gattung Adeona, Hamburg, 1879.

The following is a list of the recent forms I should include in the subgenus *Adeonella* (*Eschara*, pars), Auctt.

* (1) *Adeonella atlantica*, n. sp.
* (2) *Adeonella platelea*, Busk.
* (3) *Adeonella intricaria*, n. sp.
* (4) *Adeonella polymorpha*, n. sp.
* (5) *Adeonella regularis*, n. sp.
(6) *Adeonella tuberculata*, n. sp. = *Eschara lichenoides*, Brit. Mus. Cat., *nec* Milne-Edwards.
* (7) *Adeonella distoma*, Busk (*coscinophora*, pars, Auctt).
(8) *Adeonella fuegensis*, Busk.
(9) *Adeonella sulcata*, Milne-Edwards.
(10) *Adeonella arcuata*, Busk, MS.
(11) *Adeonella falciformis*, Busk, MS.
(12) *Adeonella lichenoides*, Milne-Edwards.
(13) *Adeonella megapora*, n. sp., MS.
(14) *Adeonella dolichostoma*, n. sp., MS.
(15) *Adeonella natalensis*, n. sp., MS.
(16) *Adeonella crassa*, n. sp., MS.
(17) *Adeonella pallasii*, Heller.
(18) *Adeonella helleri*, n. sp. ? MS.
(19) *Adeonella dispar*, Macgillivray.
(20) *Adeonella mucronata*, Macgillivray.
(21) *Adeonella pectinata*, n. sp.
(22) *Adeonella fissa*, Hincks.
(23) *Adeonella subsulcata*, Smitt.

Of this number, only those marked with an asterisk occur in the Challenger Collection.

3. The genus *Reptadeonella* includes the following species, which does not occur in the Challenger Collection :—

(1) *Reptadeonella violacea* (Johnston).

The Family here contains the following genera and species :—

1. *Adeona*, Lamouroux.

(1) *Adeona appendiculata*, n. sp. (Pl. XXXIII. fig. 6, and woodcut).

2. *Adeonella*, n. gen.

(1) *Adeonella polymorpha*, n. sp. (Pl. XXI. figs. 1*a*, 2*a*, and 3).
(2) *Adeonella platalea*, n. sp. (Pl. XXI. fig. 4).
(3) *Adeonella intricaria*, n. sp. (Pl. XXI. fig. 2).
(4) *Adeonella atlantica*, n. sp. (Pl. XX. fig. 7).
(5) *Adeonella regularis*, n. sp. (Pl. XX. fig. 2).
(6) *Adeonella distoma*, Busk.
(7) *Adeonella distoma*, var. *imperforata*?
(8) *Adeonella pectinata*, n. sp. (woodcut).

1. *Adeona*, Lamouroux.

Adeona, Lamx.; Lamk.; Kirch.; Auctt.
Dictyopora, Macgilliv., Nat. Hist. Vict., Dec. v. p. 37.

Character.—Zoarium erect, foliaceous, expanded, flabellate or lobate, fenestrate or entire, usually supported on a flexible or subflexible, chitino-calcareous, usually jointed stem, composed of radical tubes encrusted with calcareous matter, and attached by spreading radical fibres. If without a stem, generally attached to a flexible support.

1. *Adeona appendiculata*, n. sp. (Pl. XXXIII. fig. 6, woodcuts 47 and 48).

Character.—Zoarium light buff in colour; in the form of a simple flat circular or subcordiform expansion about 3″ in diameter, supported on a solid calcareous stem (probably continued into an articulated peduncle). Fenestræ circular, nearly as wide as the interspaces. Zoœcial cells oval, convex in front, with a large deep frontal fossa surrounded with a thick, rounded, smooth border; in the fossa a large circular pore at the lower part, and a very large avicularium with a spear-shaped mandible pointing upwards and rising to the side of the orifice. Orifice irregularly elliptical, usually rendered oblique by the presence of the avicularium. A single or double row of punctures round the border of the cell, and a few sparsely distributed on the front. Oœcial cells larger, orifice semicircular with a straight lower border. Avicularian cells of two kinds, one marginal around the fenestræ, with long curved pointed mandible, and another of minute size interspaced among the zoœcia with miniature mandibles, like those on the zoœcial cells. Opercula of the zoœcial cells inapparent; of the oœcial, very indistinct.

Habitat.—Station 163A, off Twofold Bay, 150 fathoms, green mud.

The only other species, and with which the present can, from its habit, be confounded, is the *Adeona grisea* of Mr. Macgillivray, which may or may not be the same as the *Adeona grisea* of Lamouroux and Kirchenpauer, though the latter at any rate may be doubtful. Mr. Macgillivray's figure (*loc. cit.*, Dec. vii. pl. lxvi. fig. 1), in the general habit bears

a strong resemblance to *Adeona appendiculata*, which is however more decidedly cordiform at the base and has a much longer rigid calcareous stem, but the characters of the zoœcia themselves differ very widely. The lateral papillary eminence below the mouth, which is seen in several other species, is wanting in *Adeona appendiculata*, and to judge from Mr. Macgillivray's figures the frontal avicularia in *Adeona grisea* are much smaller, and he makes no mention of the marginal avicularian cells, which form a marked feature in *Adeona appendiculata*.

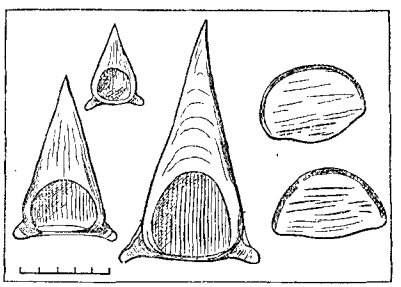


FIG. 47.—*Adeona appendiculata*.

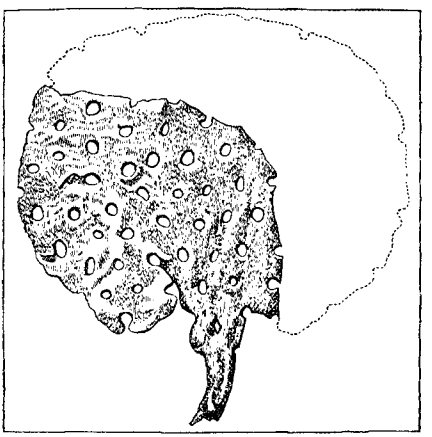


FIG. 48.—*Adeona appendiculata* (nat. size).

As regards colour, again, which is a very important character in the Adeoneæ, although Mr. Macgillivray does not notice it in his description, there is a very striking difference between the two. To judge from several fine specimens of what I take to be the *Adeona grisea* of Macgillivray lately sent by Mr. Wilson to the British Museum, the colour of that species is nearly black, whilst in the beautifully perfect and well-preserved specimen in the Challenger Collection the colour is that of a lightly baked biscuit. In *Adeona grisea*, also, the mandibles of the frontal avicularia are much smaller and nearly triangular, with an obliquely curved point, and those of the avicularian cells of the same character only much larger, and not at all like the marginal avicularia of *Adeona appendiculata*. *Adeona grisea* has distinct though delicate elliptical opercula both of the zoœcial and oœcial cells.

But another character which would alone suffice to distinguish *Adeona appendiculata* is the presence of the intercalated minute avicularia among the cells, and apparently not always if ever connected with any individual zoœcium. This character does not appear to exist in any other species with which I am acquainted. As the species is imperfectly figured in the Plates, woodcuts are given one of the organism, natural size, the other of the chitinous parts.

2. *Adeonella*, n. gen.

Eschara (pars), Auctt.

Character.—Zoarium erect, very variously branched or lobate, attached by a contracted base, or pedicle, often containing radical fibres and affixed usually on a more or less flexible support.

It is extremely difficult to point out any very definite line of distinction between some of the forms included under this subgenus and some of the non-fenestrate species placed under *Adeona*, as for instance *Adeona foliifera*, Lamarck, or *Adeona intermedia*, Kirchenpauer. The main difference consists in the absence in all cases of a jointed flexible stem, which again may or may not be present in one and the same species of the fenestrate kind as is the case in the species I propose to name *Adeona gattyæ*. But it is curious to observe that the want of flexibility in the peduncle itself is, in all instances that have come under my notice, supplied by the support itself being flexible, such as some hydroid growth, or fibre of *Gorgonia*, or *Antipathes*, a *Fucus*, sponge, &c.

As regards the general zoœcial characters, there is no difference whatever between *Adeona* and *Adeonella*, and in one respect the zoaria of the two resemble each other, for in many cases among the *Adeonellæ* there is a distinct midrib on the main stem and lobes, of precisely the same nature as the peculiar raised veins or ridges seen in most of the *Adeonæ*.

(1) *Adeonella polymorpha*, n. sp. (Pl. XXI. figs. 1*a*, 2*a*, 3, 3*a*, not figs. 1 and 2).

Character.—Zoarium 3 or 4 inches high, very thin, alternately pinnate like many ferns, with very strongly marked midribs. Zoœcial cells diversiform; when young, ovate or pyriform, convex or subcarinate in front with one or two longitudinal rows of puncta on the sides; when mature hexagonal and hollowed in front, the surface entire or very indistinctly punctured; a large circular simple pore, which in the young cell is formed immediately below the orifice by the constricting of the notch in the lower border, and thence gradually descends so as to become nearly central. Usually one or more small avicularia on the front, irregularly placed. The primary orifice suborbicular and emarginate, or clithridiate; in the mature cells, orbicular or elliptical with a thin peristome. Oœcial cells, larger, broadly ovate, and convex in front, the surface thickly punctured all

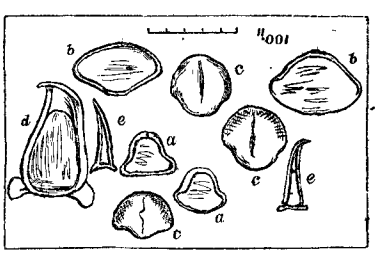


FIG. 49.—*Adeonella polymorpha.*

over, primary orifice arched above and sinuate below; afterwards crescentic and narrow owing to the rising in front of it of a thick transverse bridge beneath which is formed the suboral pore, often divided into two; and on each pier of the bridge a minute avicularium. Avicularian cells all marginal, with a short strong curved mandible pointing upwards.

Habitat.—Samboangan, 10 fathoms.

The chitinous appendages shown in the woodcut consist of *a,a*, probably immature zoœcial opercula which are rare; *b,b*, oœcial opercula; *c,c,c*, zoœcial opercula, which are thick and solid and often cracked down the middle; *d*, the mandible of a marginal avicularium; *e,e*, mandibles of frontal avicularia.

(2) *Adeonella platalea*, Busk (Pl. XXI. figs. 4, 4*a*, excluding the branched figure).

Eschara platalea, Bk., Brit. Mus. Cat., pt i. p. 90, pl. cv. figs. 1, 2, 3, and pl. cviii. fig. 4; Macgilliv., *loc. cit.*, Dec. vol. v. p. 41, pl. xlviii. fig. 4.

? *Eschara hexagonalis*, Haswell, Proc. Linn. Soc. New South Wales, 1881, vol. v. p. 41, pl. iii. figs. 1, 2.

Character.—Zoarium branched or irregularly lobate. Cells trimorphous. Zoœcia very uniform, hexagonal; convex or tumid in front with a smooth, uneven, entire surface, obscurely pitted round the border; in the older cells hollowed slightly in front. A large circular pore placed in the upper part of the front, on the sides one or more small avicularia (often absent). Orifice orbicular, with a thick rounded entire peristome. Oœcial cells larger, barrel-shaped, the wall closely punctate. Orifice (primary) broadly clithridiate or sinuate, afterwards semicircular or subcrescentic; a large suboral pore formed by the inarching of two tubercular processes, one on each side of the orifice and forming a bridge, beneath which is the pore, often divided into two; and on either side of the bridge a minute avicularium. Avicularian cells marginal or sometimes intercalated, the latter having a strap or spoon-shaped mandible.

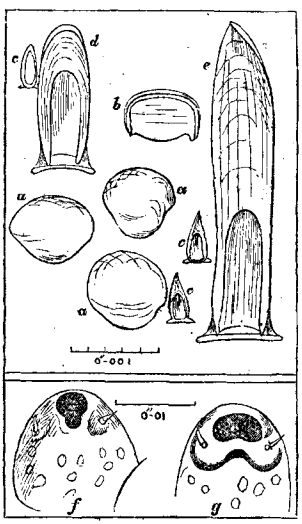


FIG. 50.—*Adeonella platalea*. *a, a, a*, Zoœcial opercula; *b*, an oœcial operculum; *c,c,c*, frontal avicularia; *d*, one of the intercalated avicularia; *e*, one of the marginal avicularia; *f*, primary mouth of a zoœcial cell; *g*, a secondary mouth.

Habitat.—Station 201, lat. 7° 3′ N., long. 121° 48′ E., 82 to 102 fathoms, stones and gravel.

[Bass Strait; off Cape Capricorn, Voy. of Rattles.; Queenscliff, Victoria, Macgillivray.]

The specimens of this species in the Challenger Collection are only a few small fragments, but in fair condition and sufficient to render

it highly probable that they belong to the same species as that procured on the Voyage of the "Rattlesnake." When calcined, the front of the zoœcia appears convex with a marginal row of punctures all round, and more sparsely punctured over the entire surface.

(3) *Adeonella intricaria*, n.sp. (Pl. XXI. fig. 2, and woodcuts 51-53).

Character.—Zoarium forms a tufted growth 2 or 3 inches in diameter, composed of narrow much compressed branches ramifying and frequently inosculating in all direc-

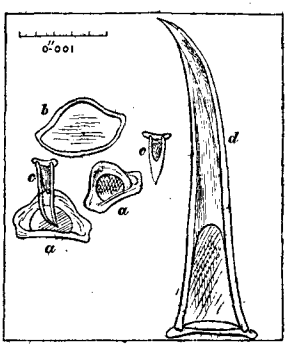


FIG. 51.—*Adeonella intricaria*. *a*, *a*, Zoœcial opercula; *b*, oœcial operculum; *c*,*c*, frontal avicularia; *d*, lateral avicularia.

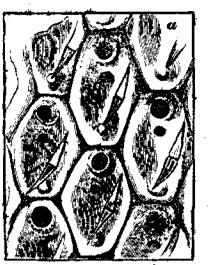


FIG. 52.—*Adeonella intricaria*. *a*, Mature zoœcial cells; *b*, an oœcial cell.

tions. Cells trimorphous. Zoœcial diversiform; when young, narrow, elongated, oval, convex in front, the convexity at the lower end rising into a conical eminence. Orifice much produced or subtubular, sometimes cucullate looking directly forwards, orbicular with a straight even lower lip. Peristome thin, entire; a large sublabial pore close below the orifice; surface obscurely punctured round the border; a small frontal avicularium, often absent. The mature zoœcia hexagonal, front much hollowed below the orifice with a well marked subconical eminence below, on the upper side of which is a large sessile avicularium whose acute projecting "beak" is prolonged obliquely downwards and inwards on the tuberosity. Mandible acutely lanceolate. Oœcial cells much larger, ovoid or pyriform, surface closely punctate. Primary mouth orbicular or semicircular, peristome projecting forwards and often cucullate. A large suboral pore often subdivided

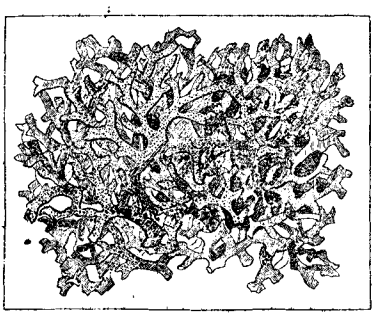


FIG. 53.—*Adeonella intricaria*. (Nat. size).

into two, and on either side, close to the angles of the mouth, a minute immersed avicularium. Avicularian cells mostly marginal, but sometimes interspersed amongst the others, with a long spear-shaped acute mandible.

Habitat.—Station 190, lat. 8° 56′ S., long. 136° 5′ E., 49 fathoms, green mud.

It is not improbable that this species may be identical with Mr. Haswell's *Eschara hexagonalis*, and not impossibly with M. Milne-Edwards' *Eschara lichenoides*, but the published materials are insufficient to determine the point. All difficulty however would at once be removed by the examination of the chitinous parts, and especially of the zoœcial opercula, which are of very peculiar and remarkable conformation in the present species, as will be seen in the figures.

(4) *Adeonella atlantica*, n. sp. (Pl. XX. fig. 7, woodcut 54).

Character.—Zoarium branched, branches expanded and bifid at the end. Cells trimorphous. Zoœcial, narrow, ovate, truncated at bottom; surface convex, rising into a rounded eminence below; sparsely punctured round the border and in three or four longitudinal rows in front. Orifice elliptical, raised, peristome sometimes cucullate. Median pore large, simple, circular, much depressed; a large avicularium on one side directed obliquely upwards and inwards towards the middle of the orifice over which it slightly projects; often a smaller avicularium on the opposite side near the orifice.

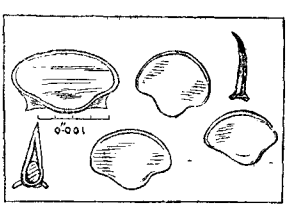


Fig. 54.—*Adeonella atlantica.*

Habitat.—Stations 135A and C, off Inaccessible and Nightingale Islands, Tristan da Cunha, 75 and 110 fathoms.

[Tierra del Fuego, 19 fathoms, Darwin; South Africa? Miss Gatty; ? Gulf of Florida, 10 to 18 fathoms, Pourtalés.]

I have inserted the last locality in some doubt whether the present species may not possibly be identical with Prof. Smitt's *Porina subsulcata* (Florid. Bryoz., part ii. p. 28, pl. vi. figs. 136–140). One of the most obvious characters of the species is the usually large avicularium pointing upwards and inwards so as to project slightly over the lower border of the mouth; another is the absence or comparative shallowness of the frontal depression and, when decorticated, the cribriform puncturation of the whole surface; and a third, the usually subcrescentic form of the mouth in the zoœcial cells; the frontal pore appears in this species to be unconnected with the mouth.

(5) *Adeonella regularis*, n. sp. (Pl. XX. fig. 2, woodcut 55).

Character.—Zoarium broadly lobate, thick. Cells disposed in very regular order, quincuncially, and separated by wide deep sulci, trimorphous. Zoœcial, rhomboidal or square with an angle at top and bottom; front very convex. In the natural state the

surface smooth and shining, when decorticated sparsely punctured all over. Orifice arched with a straight deeply emarginate lower lip. An avicularium with a curved, lanceolate, acuminate mandible pointing inwards on either side immediately above the mouth; in the mature cells a slender bridge in front of the deeply depressed mouth, formed by the gradual upgrowth of the wall on each side (not of the peristome proper). A very minute suboral pore is occasionally formed by the cutting away of a portion of the labial fissure.

Oœcial cells of the same form as the zoœcial but with a differently shaped operculum. Avicularian cells numerous, marginal, small.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, green sand.

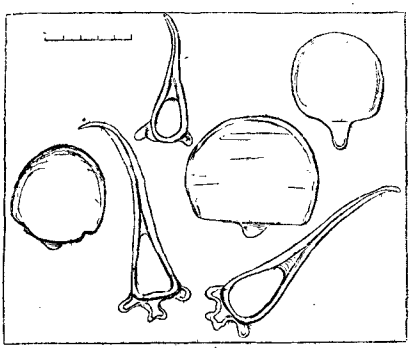


FIG. 55.—*Adeonella regularis*. *a*, Zoœcial operculum; *b*, *b*, oœcial opercula; *c*, *c*, *c*, mandibles.

I have not been able to distinguish the oœcial from the zoœcial cells in the natural condition, but infer that there must be such from the presence of the widely different form of opercula presented in a decalcified preparation. And with reference to this it should be noticed that, in some parts, cells may be observed in which there is no indication whatever of mouth or orifice of any kind, the front instead rising into a subconical eminence upon which a very minute avicularium is placed. Whether these are merely occluded zoœcial cells or represent oœcia may be doubtful. As regards the peculiar bridge formed in front of the mouth, it should be understood that it has nothing to do with the peristome, but is formed entirely from an upgrowth of the thickly calcified wall, the mouth remaining of its original conformation and with an unaltered peristome at the bottom of a deep pit.

What may be the perfect habit, size, or mode of attachment of the species cannot be ascertained from the fragmentary portions in the Challenger Collection.

(6) *Adeonella distoma* ? Busk (woodcuts 56, 57).

? *Eschara coscinophora*, Reuss, ? Foss. W. Tertiarb. p. 67, pl. viii. fig. 20.
„ „ *Id.*, Bryoz. des Sept., p. 70, pl. xi. figs. 1–4.
„ „ *Id.*, Fauna des deutsch. Oberoligocäns II. p. 36, pl. xii. fig. 12.
„ „ Stoliczka, Sitzungsb. d. k. Akad. Wiss. Wien, Bd. I. p. 89, pl. ii. fig. 11, and pl. iii. figs. 1, 2.
„ „ Manzoni, Brioz. fossil. d. Miocene d'Austria ed Ungheria, p. 14, pl. viii. fig. 25.
? *Porellina coscinophora*, d'Orbigny, Palæont. Franç., p. 476.
Lepralia distoma, Busk, Quart. Journ. Micr. Sci., vol. vi. p. 127, pl. xviii. fig. 1.

Character.—Zoarium composed of long straggling ligulate branches (sometimes

decurrent or adnate). Zoœcia of one kind only (?) elongated, oval. Oral end prominent, subtubular, and bending forwards, especially in the lateral cells. Orifice arcuate with straight entire lower border. Immediately below the mouth is a median avicularium with an acute mandible pointing upwards and projecting usually beyond the lower border of the mouth. Below, the zoœcium is immersed, convex on the sides with an oval perforated areola in front, pierced by about seven fimbriate pores.

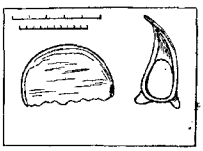


Fig. 56.

Habitat.—Station 75, lat. 38° 38′ N., long. 28° 28′ W., 450 fathoms, volcanic mud.

[Madeira, J.Y.J.; Atlantic 268 to 322 fathoms, Voy. of "Porcupine" (dead); Fossil, miocene, Reuss, &c.]

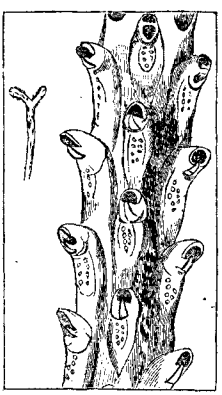


Fig. 57.

Figs. 56, 57.—*Adeonella distoma.*

The striking resemblance between the zoœcia in this form and those figured by Dr. A. E. Reuss in his later papers, is so close as to leave little room for doubt that the latter are very closely allied to if not identical with my *Lepralia distoma*. But if Dr. Reuss' earlier figure of *Eschara coscinophora*, in his Memoir on the Vienna tertiary fossils, is to be taken as the type, very considerable doubt might be thrown on the identification. But considering that the same original observer has regarded all those he figured subsequently as belonging to the same species, it would probably be right to yield the priority to him; otherwise the forms described in the later memoirs would clearly come under my designation.

The single small specimen in the Challenger Collection that I have noticed is in beautiful condition, and is shown in woodcut 57. Those I have from the "Porcupine" collection, on the other hand, are dead, and apparently much older and thicker, and they consequently demonstrate the similarity of the existing form with those of the Miocene period much more clearly than the younger living specimens.

(7) *Adeonella distoma*, var. *imperforata*, nov. (Pl. XX. fig. 4).

In the gathering from Station 122, lat. 9° 5′ to 10′ S., long. 34° 49′ to 53′ W., are one or two fragments of a small form, in which the characters of the zoœcia are precisely like those in *Adeonella distoma*, except that there is no perforated areola on the front.

(8) *Adeonella pectinata*, n. sp. (woodcut 58).

Character.—Zoarium about 1″ high, compressed obscurely carinate, expanding at the end, with short lateral branches or lobes. Cells trimorphous; zoœcial, narrow, ovate, and separated by shallow sulci. Front convex, and slightly hollowed in the middle with wide punctures. Mouth elliptical, transversely elongated, lower lip straight, entire, and within it a delicate pectinate denticle extending from side to side. A minute frontal avicularium on one side in a few of the zoœcia. Sublabial pore of large size. Oœcial cells rather larger, orifice arcuate, and in the mature cells with a straight lower border and a pectinate internal denticle. Most unarmed, but others have a small avicularium on a tubercular elevation on each side of the orifice. In these cells the pore is reniform, and placed low down on the front. Avicularian cells all marginal, of large size. Mandible of the retentive kind, obtuse, incurved at the point.

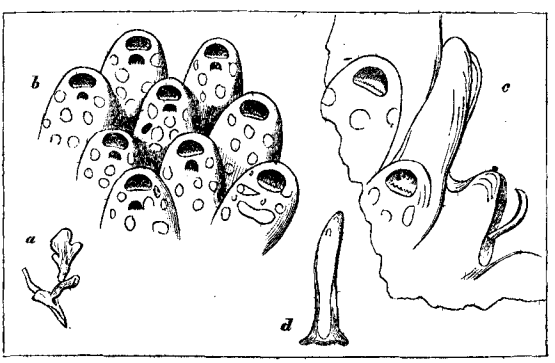


FIG. 58.—*Adeonella pectinata*. *a*, Natural size; *b*, zoœcia; *c*, marginal avicularium; *d*, mandible.

Habitat.—Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

This is the only species of Adeonella in which I have noticed an internal denticle, by the presence of which it may consequently be at once distinguished; the retentive spatulate marginal avicularia are also distinctive; in all other cases so far as I know, those organs being of the prehensile nature. Unfortunately the collection affords only a single specimen, which it is desirable to keep entire, so that I have not attempted to isolate the chitinous parts, and can say nothing of the character of the operculum. The avicularian mandible however can be seen without any preparation; the position of the median pore, low down on the front of the oœcial cells, is also an exceptional feature.

Family XXII. Celleporidæ.

Celleporidæ, Johnst., Brit. Mus. Cat., Hincks, &c.
Escharidæ (pars), d'Orb.
Myriozoidæ (pars), Smitt.

Character.—Zoœcia urceolate, erect or suberect, irregularly heaped together and often forming several superimposed layers.

1. *Cellepora.*

Cellepora (pars), Fabric., Linn., &c., Brit. Mus. Cat., Johnst., Hincks, Auctt.
Tubipora (pars), Linn.
Millepora (pars), Ell. and Soland.
Celleporaria, Lamx., Reuss, d'Orb., &c.
Spongites, Oken.

Character.—Zoarium multiform; lamellar and encrusting, partially adnate, or free; or erect and attached by a thick base, massive or irregularly branched, solid or hollow; or in the shape of small parasitic pisiform or discoid growths. Zoœcia in the older portions more or less erect or vertical, very irregularly disposed or heaped together. Orifice entire or sinuated in front, with or without internal denticles. A pre-oral rostral process (sometimes aborted) usually supporting an avicularium; very generally interspersed avicularia.

The species here enumerated of this multiform and perplexing genus, may be conveniently arranged in two principal more or less artificial sections or groups, characterized primarily by the form of the operculum and secondarily by the general zoarial habit.

§ 1. Operculum suborbicular or semicircular, with a nearly straight lower border; avicularian mandibles usually with a short median columella.[1]

§§ *a. lobate, branched, or massive.*

(1) *Cellepora hastigera*, n. sp. (Pl. XXIX. fig. 1).
(2) *Cellepora tuberculata*, n. sp. (Pl. XXVIII. fig. 9).
(3) *Cellepora albirostris*, Smitt (Pl. XXXIV. fig. 7).
(4) *Cellepora aspera*, n. sp. (Pl. XXVIII. fig. 6).
(5) *Cellepora columnari*, n. sp. (Pl. XXIX. fig. 11).
(6) *Cellepora honolulensis*, n. sp. (Pl. XXIX. fig. 5).
(7) *Cellepora imbellis*, n. sp. (Pl. XXIX. fig. 7).
(8) *Cellepora jacksoniensis*, n. sp. (Pl. XXX. fig. 10).
(9) *Cellepora polymorpha*, n. sp. (Pl. XXX. fig. 11).

[1] This character, however, seems to be confined to species belonging to the Southern Hemisphere, as it is not present in the Mediterranean *Cellepora sardonica* and *Cellepora digitata*.

§§ β. *encrusting.*

(10) *Cellepora apiculata*, n. sp. (Pl. XXIX. fig. 2).
(11) *Cellepora samboangensis*, n. sp. (Pl. XXX. fig. 7).
(12) *Cellepora discoidea*, n. sp. (Pl. XXX. fig. 8).
(13) *Cellepora trident*i*culata*, n. sp. (Pl. XXIX. fig. 3).
(14) *Cellepora vagans*, n. sp. (Pl. XXIX. fig. 10).
(15) *Cellepora mamillata*, var. *atlantica*, Busk (Pl. XXXV. figs. 4 and 5).

§ 2. Operculum pedunculate or produced downwards, with an articular notch on each side; no columella in the prehensile mandibles. Orifice usually emarginate in front.

§ *a. lobate, branched, or massive.*

(16) *Cellepora rudis*, n. sp. (Pl. XXVIII. fig. 7).
(17) *Cellepora solida*, n. sp. (Pl. XXIX. fig. 12).
(18) *Cellepora simonensis*, n. sp. ? (Pl. XXIX. fig. 9).
(19) *Cellepora pustulata*, n. sp. (Pl. XXVIII. fig. 8).
(20) *Cellepora cylindriformis*, n. sp. (Pl. XXX. fig. 9).
(21) *Cellepora eatonensis*, n. sp. (Pl. XXIX. figs. 4, 6, 8).
(22) *Cellepora ovalis*, n. sp. (Pl. XXVIII. fig. 5).

§§ β. *pisiform.*

(23) *Cellepora bicornis*, n. sp. (Pl. XXX. figs. 1 and 12).
(24) *Cellepora bilabiata*, n. sp. ? (Pl. XXX. fig. 2).
(25) *Cellepora signata*, n. sp. (Pl. XXX. fig. 3).
(26) *Cellepora conica*, n. sp. ? (Pl. XXVIII. fig. 10).
(27) *Cellepora ansata*, n. sp. (Pl. XXX. fig. 4).
(28) *Cellepora canaliculata*, n. sp. (Pl. XXX. fig. 5).
(29) *Cellepora bidenticulata*, n. sp. (Pl. XXX. fig. 6).
var. *subæqualis*, nov. (Pl. XXXVI. fig. 11).
(30) *Cellepora granum*, Hincks (Pl. XXXVI. fig. 10).
(31) *Cellepora tubulosa* (Hincks, sp. ?).

The number of species here referred to the genus *Cellepora* is about 30 or 31.

1. Of which the North Atlantic region yielded three, from depths varying from 51 to 450 fathoms.

2. The South Atlantic nine, from depths varying from 5 to 600 fathoms.

3. The Kerguelen or South Indian Region six, all from the neighbourhood of Kerguelen Island, and from depths varying from 20 to 500 fathoms.

4. The Australian Region twelve, all, with one exception (*Cellepora solida*), from depths varying from 2 to probably not more than 40 fathoms. The exception is a very aberrant form and only doubtfully referred to the same genus; it was procured from a depth of 2600 fathoms.

5. The North Pacific region furnished four species, at depths varying from 10 to 30 fathoms.

6. The South Pacific, only two, one from a depth of 45 fathoms, whilst the other appears to have been brought up from 1325 fathoms, near the western coast of South America. A curious circumstance, since the same species, *Cellepora eatonensis* (var. *magellanica*), occurred near the Falkland Islands at a depth of not more than 5 to 12 fathoms.

On the whole the genus as represented in the present collection would appear to belong to comparatively shallow water.

§ 1. Operculum suborbicular or semicircular with a nearly straight lower border; avicularian mandibles with a short median columella.[1]

§§ *a. lobate, branched, or massive.*

(1) *Cellepora hastigera*, n. sp. (Pl. XXIX. fig. 1, and Pl. XXXV. fig. 8).

Character.—Zoarium erect, expanded, lobate. Zoœcia deeply immersed, surface entire, dull. Orifice (primary) suborbicular, with a slightly sinuated lower border and no spines. Pre-oral rostra of two kinds, one very stout and subconical, supporting on the posterior face, either at or near the apex or lower down, an avicularium with either an acute or a duck-bill shaped mandible, and a toothed beak; the other slenderer and very acute, with a small lateral semicircular avicularium at the base overhanging a notch.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

In some respects the characters of this form render it doubtful whether it may not be a variety of *Cellepora bispinata*, Brit. Mus. Cat., or *Cellepora* (*Discopora*) *albirostris*, Smitt, Florid. Bryoz., but the total absence of any sign of the two long slender oral spines, present in those species, and the different form and proportions of the pre-oral rostral processes, render them, in my opinion, sufficiently distinct.

[1] *Vide* note, p. 190.

(2) *Cellepora tuberculata*, n. sp. (Pl. XXVIII. fig. 9, and Pl. XXXV. fig. 7).

Character.—Zoarium a rounded, massive irregularly nodular growth. Zoœcia perfectly upright, very deeply immersed below and more or less free above; often assembled in sets of three or four together. Orifice suborbicular or elliptical, about 0″·007 wide; a few excessively minute denticles within the lower border. Operculum subtriangular, rounded, about 0″·006 in diameter. Pre-oral rostrum small, conical obtuse, most frequently represented by a mere transverse tubercle; on the back of which is a very minute avicularium with a semicircular mandible. Oœcium partially recumbent, free, with a round pore on each side in front. Interspersed avicularia rare, columnar, vicarious; mandible blunt, triangular; beak obtuse, not toothed.

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

The open honey-comb appearance of the surface in this form and the peculiar habit (if constant) are at first sight very characteristic.

(3) *Cellepora albirostris*, Smitt (Pl. XXXIV. fig. 7, and Pl. XXXV. fig. 3).

Discopora albirostris (*forma typica*), Smitt, Florid. Bryoz. pt. ii. p. 70, pl. xii. figs. 234–239; (*nec.* Hincks).

? *Cellepora bispinata*, Busk, Brit. Mus. Cat., p. 87, pl. cxx. figs. 1, 2.

Character.—Zoarium massive, or irregularly lobate; erect, or partially encrusting sponges or *Fucus*. Zoœcia (marginal) barrel-shaped, surface pearly, smooth or finely granular; imperforate or with a few punctures round the border. Orifice (primary) suborbicular or arcuate; two long, very slender, unarticulated oral spines above; rostrum (where fully formed) very long, straight and acuminate, solid with a minute avicularium with semicircular mandible on one side of the base, and overhanging a wide sinus. On the older zoœcia, often a long solid upright acuminate spine, arising apparently from the side of the zoœcium about the middle of its length. The rostrum is often developed into a very thick subcylindrical process obliquely truncated at the end and presenting on the oblique face a large avicularium with a blunt spatulate mandible and toothed beak (fig. 7*d*). A few interspersed immersed retentive avicularia, usually placed transversely on the front of a zoœcium, and varying greatly in size; the mandible elongated obtuse or subspatulate, the beak simple or rounded.

Habitat.—Station 151, off Heard Island, 75 fathoms, volcanic mud.

As Prof. Smitt remarks, the typical *Cellepora albirostris* in a fresh condition is readily recognisable by its greyish-brown colour and blackish-brown operculum. The zoœcia, he goes on to observe, in the growing edge of the colony are elongated ovate, presenting the greatest resemblance to *Cellepora bispinata*, Brit. Mus. Cat. In this I quite agree with

Prof. Smitt, and am strongly inclined to think that his *Cellepora albirostris* is identical with my *Cellepora bispinata*. Unfortunately I have no specimen of the latter to compare, and the figure and description in the Brit. Mus. Cat. are hardly sufficient to determine the point. Under these circumstances I have thought it best to retain Prof. Smitt's appellation. I would remark, however, that the term "very minute," as applied to the usual kind of rostral avicularium, quite accords with that of *Cellepora albirostris;* the large rostral avicularia are only occasional.

With respect to Prof. Smitt's supposition that *Cellepora albirostris* and my *Cellepora mamillata* may be connected, I would observe, if I understand him correctly, that there can be no doubt of their complete distinctness. Nor can I see any reason for regarding the form described by Prof. Smitt under the name of *Cellepora* (*Discopora*) *pusilla* as merely a variety of his *Cellepora albirostris;* the two seem to me quite distinct, and how their close relation is "incontestably proved by the very same form of their zoœcial aperture," seems to me to be by no means clear, seeing that the form of aperture in question is one of very common occurrence.

(4) *Cellepora aspera*, n. sp. (Pl. XXVIII. fig. 6).

Character.—Zoarium erect, cylindrical, irregularly branched, branches expanded at the end. Zoœcia immersed and ventricose below, produced or subtubular upwards, with a single row of punctures round the base, surface smooth, wall thick and porcellanous. Orifice suborbicular, with a wide sinus within which is an avicularium with a semicircular mandible; peristome thick, even. A few interspersed vicarious avicularia with short spatulate mandible. Oœcia? Operculum transversely elliptical, with a nearly straight lower border, 0″·0055 × ·004.

Habitat.—Station 122, 9° 5′ S., 34° 50′ W.; 350 fathoms, red mud.

The single specimen of this species is old and partially dead.

(5) *Cellepora columnaris*, n. sp. (Pl. XXIX. fig. 11, and Pl. XXXV. fig. 16).

Character.—Zoarium expanded, thick, irregular in form and extent. Zoœcia deeply immersed, ventricose, but with the outlines very obscure; substance of wall solid, porcellanous; surface finely granular; orifice semicircular, lower lip straight and entire. A long, solid, tapering, columnar process springs from the back of the zoœcium close to the mouth, and rather to one side. In many zoœcia there is a small tubercular avicularian process in front below the orifice, which also sometimes rises in a columnar form; mandible triangular.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

(6) *Cellepora honolulensis*, n. sp. (Pl. XXIX. fig. 5, and Pl. XXXV. fig. 15).

Character.—Zoarium massive, irregular. Zoœcia very confusedly crowded, deeply immersed, surface finely granular, imperforate. Orifice (primary) semiorbicular, or subtriangular, lower border straight, with a minute three-toothed pectinate process within it. A short pointed pre-oral rostrum, supporting on one side a small avicularium, with a semicircular mandible. In the older parts, very numerous large interspersed prominent avicularia, with a lanceolate mandible pointing upwards, and simply channelled beak.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

Differs from *Cellepora tridenticulata* in the much smaller size of the internal denticles, which rather resemble a minute three-toothed comb, and in the almost universal presence on the front of the older zoœcia of a prominent avicularium with a lanceolate mandible and simply channelled not serrated beak.

(7) *Cellepora imbellis*, n. sp. ? (Pl. XXIX. fig. 7, and Pl. XXXV. fig. 20).

Character.—Zoarium lamellar, flexuose, thin. Zoœcia distinct, erect, free above, ventricose and immersed below; surface finely pitted. Orifice arcuate or subtriangular or suborbicular, about 0″·006 wide, peristome slightly thickened; a small avicularium in front just within the border. A few interspersed, immersed avicularia, with duck-bill mandible.

Habitat.—Off Bahia, 10 to 20 fathoms.

Only a single specimen apparently old and dead.

(8) *Cellepora jacksoniensis*, n. sp. (Pl. XXX. fig. 10, and Pl. XXXV. fig. 9).

Character.—Zoarium branched; branches compressed. Zoœcia barrel-shaped, very distinct at the growing edge (fig. 10*a*), elsewhere confused; surface granular; a row of small perforations round the border. Pre-oral process short, pointed, trifid, having an avicularium, with a rounded mandible, on one side towards its base, which forms one border of the labial fissure. Orifice orbicular, widely notched below. Some of the lateral zoœcia have in front a strong projecting avicularian process, with a lanceolate mandible, and the beak cupped and toothed (fig. 10*b*).

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

(9) *Cellepora polymorpha*, n. sp. (Pl. XXX. fig. 11).

Zoarium irregularly branched, branches tapering, short. Zoœcia very confusedly disposed; surface coarsely granular. Orifice (primary), (fig. 11*a*), circular, widely emargin-

ate; afterwards the peristome becomes much thickened and raised (fig. 11*b*), so as to conceal the primary mouth. Three or four acute curved denticles within the peristome, which in this stage is unarmed. In other zoœcia the labial sinus becomes fissural, and eventually converted more or less completely into a suboral pore, whilst in front the peristome forms a prominent tubercular eminence (fig. 11*c*), supporting on the side overlooking the fissure a large avicularium, with a rounded triangular mandible and toothed beak. A few interspersed avicularia (fig. 11*d*,*e*), on low horizontal eminences, with a spatulate retentive mandible often squarely truncated, and bifid beak. Oœcia (fig. 11*f*), erect or subrecumbent, globose; surface finely granular. Opercula semicircular about 0″·008 × ·0035.

Habitat.—Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

§§ *β. encrusting.*

(10) *Cellepora apiculata*, n. sp. (Pl. XXIX. fig. 2, and Pl. XXXV. fig. 12).[1]

Character.—Zoarium encrusting, or unilaminar and unattached. Zoœcia (at the growing edge), ventricose or barrel-shaped, with a granular unpunctured surface. In the older portions deeply immersed and very confusedly disposed, varying much also in size. Primary orifice semicircular, with a straight entire lower border, and surmounted in the earliest stage by two, or more rarely three, long oral spines. Pre-oral rostrum very irregular in size and supporting usually on one side a large avicularium with an obtuse serrated beak, and a subacute lanceolate or triangular mandible, and usually produced beyond the avicularium into a longer or shorter, obtusely apiculate spine.

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground.

The extreme irregularity of growth and great diversity in the form and size of the pre-oral rostrum, which is sometimes very small, and at others developed into a very large avicularian process, render any definite description of this species very difficult. The chief points it presents are: 1. The semicircular orifice (about 0″·07 wide), with a straight entire lower lip; 2. The, at first, short and thick hollow rostrum, which afterwards becomes produced into an obtuse spine, and on the side of the wider portion, some distance above the base, supports on one side a large avicularium with a finely serrated beak and rather blunt but elongated mandible; 3. The presence on the youngest zoœcia only of two or sometimes three long oral spines, like those in *Cellepora bispinata*, Busk, or *Cellepora albirostris*, Smitt.

(11) *Cellepora samboangensis*, n. sp. (Pl. XXX. fig. 7, and Pl. XXXV. fig. 10).

Character.—Zoarium expanded, thick, loosely adnate, surface uneven but not distinctly mamillated. Zoœcia distinct, very confusedly disposed, obscurely punctured

[1] The figure has unfortunately been taken from a very bad specimen, and shows little of the real characters. The chitinous parts, however, suffice to distinguish it.

round the border; the interspaces are sometimes irregularly cancellated. Surface porcellanous. Primary orifice suborbicular, situated below; operculum semiorbicular with a straight lower border about 0″·006 × ·004. Pre-oral rostrum small, conical, obtuse, presenting on one side near the base a very minute avicularium, with a semi-elliptical mandible pointing upwards. Interspersed prominent avicularia, with a short duck-bill shaped mandible and simple non-serrated beak. Very rarely one of large size, completely immersed, with a long spatulate obtuse mandible very wide at the base.

Habitat.—Off Samboangan, 10 fathoms.

In the figure the orifice is represented as notched on one side, but the apparent notch is merely caused by the projection of the base of the rostrum; the rostral avicularium is represented larger than it should be. The form may probably be only a variety of *Cellepora polymorpha.*

(12) *Cellepora discoidea*, n. sp. (Pl. XXX. fig. 8, and Pl. XXXV. fig. 1).

Character.—Zoarium (in a single specimen) discoid, unilaminar, attached only at the centre. Zoœcia (at the growing edge) ventricose; surface granular, entire. Primary orifice (fig. 8*b*) suborbicular or elliptical with a minute three-toothed process within the lower border, which is gradually developed into a large pre-oral rostrum (fig. 8*a*) on one side at the base of which is a small labial sinus and posteriorly a large avicularium with a duck-bill shaped mandible and a toothed beak (*c*); beyond which the rostrum in the older zoœcia is produced in the form of a strong conical solid spine. A few interspersed recumbent, subimmersed avicularia with a long lanceolate retentive mandible and simple non-serrated beak (*d*).

Habitat.—Station 186, off Cape York, 8 fathoms, coral mud.

The peculiar characters of this species are derived from: 1. The entire suborbicular orifice, within the lower border of which is, in quite the earliest stage, after the calcification of the front of the zoœcium is completed, a minute tridenticulate process, which appears progressively to become a rounded eminence (fig. 8*b*), toothed or serrated at the summit, the serrations forming the upper border of an avicularium; and as growth goes on, this eminence rises into a thick obtuse pre-oral rostrum, which always retains the serrated edge of a large avicularium (fig. 8*c*); at a still further stage this obtuse rostrum is produced beyond the avicularium into a strong conical pointed solid spine. 2. Another character is shown in the interspersed retentive avicularia, which are of a wholly different character from that on the rostrum, being elongated, deeply immersed, in the form of a shallow boat and have a long lanceolate mandible and simple non-serrated beak. It may also be remarked that in this species there are two *lemnisci* attached to the tentacular sheath.

(13) *Cellepora tridenticulata*, n. sp. (Pl. XXIX. fig. 3, and Pl. XXXV. fig. 17).

Character.—Zoœcium lamellar, expanded, apparently unattached, uneven. Zoœcia deeply immersed, surface shining, granular, imperforate. Orifice arcuate or subtriangular, with three, sometimes four, internal denticles within the lower border, and about 0″·006–·007 wide. Rostrum (sometimes absent) a small rounded tubercle seated in a shallow depression, supporting on the summit, a minute avicularium with a semicircular mandible. A strong articulated spine on each side of the orifice. Large interspersed prehensile avicularia (fig. 3*b*), apparently vicarious (certainly not rostral); usually immersed but sometimes more prominent and partially erect, with a short duck-bill shaped mandible, shutting down into a shallow boat-like beak, the edge of which is finely pectinate.

Habitat.—Station 186, off Cape York, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral mud.

This well marked species is at once recognisable by the long articulated and indistinctly jointed oral spine on each side of the orifice. The limited development of the rostrum with its little imbedded avicularium is also a well marked feature, as is also the fine pectination of the border of the cup or beak in the interspersed avicularia. Another curious feature is the frequent occurrence on the surface of the zoarium of long tubular processes or tunnels, looking like enormously elongated zoœcia. The nature of these appendages appears very obscure.

(14) *Cellepora vagans*, n. sp. (Pl. XXIX. fig. 10, and Pl. XXXV. fig. 11).

Character.—Zoarium encrusting, of a dark olive colour. Zoœcia small, with a single row of puncta round the border; surface granular. Primary orifice (fig. 10*a*) orbicular or subclithridiate, the peristome much produced in front, with a wide sinus; afterwards rising into a hollow, conical pointed rostrum, which usually supports on one side a minute avicularium, with a semicircular mandible. Numerous large interspersed avicularia, whose mandible (fig. 10*c*) sometimes expands at the extremity into three or four branches, connected by a delicate membrane, capable of being spread over foreign bodies, and is sometimes pointed, but always more or less membranous towards the end.

Habitat.—Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms. Off Honoruru, Sandwich Islands, 20 to 40 fathoms.

The peculiarities of this species are: 1. The almost tubular production of the peristome even in the youngest zoœcia; 2. the peculiar conical pointed form of the preoral rostrum, which sometimes represents merely an obtuse tubercle, but is more commonly of an acute conical shape, the apical portion of which, being denuded of the dark fuscous

epidermis, appears of an ivory whiteness, and with a finely granular surface and porcellanous aspect. The mode in which the partially membranous mandible of the larger avicularia sometimes spreads like a duck's foot over foreign bodies is very curious. In colour and superficial aspect, this form might be confounded with *Cellepora mamillata*, but they are in reality quite distinct.

(15) *Cellepora mamillata*, var. *atlantica*, Busk (Pl. XXXV. figs. 4, 5, and 13).

Cellepora mamillata, Bk., Brit. Mus. Cat., p. 87, pl. cxx. figs. 3, 4, 5.

Character.—Zoarium encrusting, mamillated. Zoœcia erect, very irregularly disposed, deeply immersed. Surface finely granular, not punctured. Primary orifice suborbicular, with a straight lower margin. An acute pre-oral rostrum, with an avicularium near its base overlooking a small notch. Interspersed avicularia of two kinds, prehensile, with a duck-bill shaped mandible, and retentive with a long spatulate, membranous mandible.

Habitat.—Off Bahia; 10 to 20 fathoms (Pl. XXXV. fig. 4). Station 148, lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms, hard ground, gravel and shells (Pl. XXXV. figs. 5 and 13).

[Coast of Patagonia, Darwin; Australia.]

Notwithstanding a slight (but constant) difference in the operculum, with respect mainly to the points of attachment of the occlusor muscles, and the apparent absence of the retentive kind of avicularia in the Australian specimens of *Cellepora mamillata*, the correspondence, in all other respects, with the South Atlantic form is so close as to leave little doubt as to the specific identity of the two forms.

§ 2. Operculum peduncular or produced downwards, usually with an articular notch on each side. No median columella in the mandibles.

§§ *a. lobate, branched, or massive.*

(16) *Cellepora rudis*, n. sp. (Pl. XXVIII. fig. 7, and Pl. XXXVI. fig. 7).

Character.—Zoarium (in a single specimen) consisting of a short thick cylindrical stem rising from a broad base, and dividing into two rounded lobes. Aspect rugose and coarse. Zoœcia completely immersed and very confusedly heaped together. Orifice subquadrangular, large (nearly 0″·01 wide), depressed. Pre-oral rostrum, in the ordinary zoœcia, merely a tubercle supporting an avicularium, with a blunt elliptical mandible, pointing downwards; in the fertile zoœcia the rostrum is developed into a broad hollow process, from which the raised border passes back on each side of the orifice to the sides of the oœcium. Oœcium deeply immersed, having on the front a crescentic disc, marked

with radiating furrows. Very numerous, interspersed, immersed avicularia, lying in all positions and of very various sizes, with a broad short mandible, much contracted at the base.

Habitat.—Station 320, lat. 37° 17′ S., long. 53° 52′ W., 600 fathoms, green sand.

(17) *Cellepora solida*, n. sp. (Pl. XXIX. fig. 12).

Character.—Zoarium ramose or globate, very irregular; in the older portions the zoœcia are, as it were, all fused together and coated with a porcellanous deposit, so that all trace of openings is lost. Zoœcia (younger) barrel-shaped, wide above. Orifice quadrangular, border entire; the zoœcium rises behind the mouth into an obtuse, conical process, usually presenting a small avicularium, with a triangular mandible, on the anterior aspect. In front of the mouth is a much larger, rounded, tumid prominence, on which are, occasionally, placed a few very minute, circular avicularia, also with an obtuse triangular mandible. Occasional large, interspersed avicularia (fig. 12*a*), with a broad short spatulate mandible. Operculum suborbicular about 0″·01 × ·0095.

Habitat.—Station 160, lat. 42° 42′ S., long. 134° 10′ E., 2600 fathoms, red clay.

The entire growth is solid and has a porcellanous aspect, and in habit bears a strong resemblance to *Celleporaria polythele*, Manzoni, Brioz. fossil. d. Miocene d'Austr. ed Ungh., p. 4. pl. i. fig. 3.

(18) *Cellepora simonensis*, n. sp. ? (Pl. XXIX. fig. 9, and Pl. XXXVI. fig. 8).

Character.—Zoarium branched or massive and irregular; surface uneven, nodulated or papillose. Zoœcia deeply immersed and ventricose, with a row of punctures round the border, and sometimes sparsely punctured all over. Orifice clithridiate, peristome thick; in the older stage annular or shortly tubular. An obtuse avicularian process on one side close below the orifice, with a broadly triangular mandible, pointing upwards. Sometimes interspersed minute immersed avicularia with a spatulate mandible.

Habitat.—Simon's Bay, Cape of Good Hope.

The operculum is of the same shape as the orifice, and has a pyriform thickening on each side (Pl. XXIX. fig. 9*a*). The interspersed avicularia in the older parts of the zoarium appear to be vicarious, *i.e.*, transformed zoœcia of small size.

(19) *Cellepora pustulata*, n. sp. (Pl. XXVIII. fig. 8).

Character.—Zoarium cylindrical, irregularly branched; branches slightly tapering. Zoœcia in the younger portions, distinct, ventricose; walls entire, uneven. Orifice clith-

ridiate, peristome thin. In the older zoœcia a small tubercular pre-oral process, having on one side a minute avicularium, with a subtriangular mandible. In the older portions the individual zoœcia are for the most part obliterated, and in these parts of the zoarium the surface presents small pustular, subhexagonal eminences, each of which has a minute avicularium in the centre. Besides these there are a few interspersed retentive avicularia with a spatulate mandible, with a very contracted base.

Habitat.—Station 167, lat. 39° 32′ S., long. 171° 48′ E., 150 fathoms, blue mud. Off Marion Island, 50 to 75 fathoms.

(20) *Cellepora cylindriformis*, n. sp. (Pl. XXX. fig. 9, and Pl. XXXVI. fig. 9).

Character.—Zoarium conical or tapering. Zoœcia large, distinct. Orifice (fig. 9*a*) orbicular, widely emarginate. A strong, incurved, cylindrical pre-oral process, supporting a large avicularium (fig. 9*a*), with a broad, equilateral triangular mandible. Interspersed avicularia (fig. 9*b*) not numerous, having a broad, short, membranous mandible, either of a duck-bill form or squarely truncate. Oœcia (fig. 9*a*) small, erect, globose, punctured.

Habitat.—Station 142, lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms, sand.

The only specimen is of a cylindrical form about 0·75 inch long, by 0·1 in diameter, appearing, but not certainly, to be moulded on a worm tube.

(21) *Cellepora eatonensis*, n. sp. (Pl. XXIX. figs. 4, 6, 8, and Pl. XXXVI. figs. 3, 4, 5).

Character.—Zoarium multiform, massive, or branched; the branches short, thick, and obtuse, or more or less lamellar, and free; or incrusting, or parasitic, and more or less globose. Zoœcia (young) barrel-shaped, (fig. 4), afterwards ventricose; surface entire, smooth. Orifice subarcuate, with a wide notch. Pre-oral rostrum very variable in size and conformation; small and conical, or very large and cylindrical towards the end, and deeply channelled on the posterior aspect, but always hollow (fig. 8 *b*), supporting near the extremity a small avicularium, with a semicircular mandible. Numerous very large interspersed avicularia, with a duck-bill shaped mandible, shutting down into a deep cupped beak, the end of which is gouge shaped, and the border entire and sharp.

Habitat.—Station 149D, RoyalSound, Kerguelen, 28 fathoms. Stations 149 H, J, K, off Christmas Harbour, Kerguelen, 45 to 127 fathoms. Station 303, lat. 45° 31′ S., long. 78° 9′ W., 1325 fathoms, Globigerina ooze. Station 315, lat. 51° 40′ S., long. 57° 50′ W., 5 to 12 fathoms, sand.

Though exhibiting considerable diversity, especially in the greater or less development of the rostrum, the specimens from the above localities agree in all essential particulars,

such as the shape of the orifice and operculum, the presence of the small rostral semicircular avicularium, which is sometimes terminal, sometimes seated below the summit, which may be prolonged into an acuminate point beyond it,—but more particularly by the peculiar conformation of the numerous and large interspersed avicularia. At first I was disposed to divide the form into three species, *Cellepora eatonensis*, *Cellepora magellensis*, and *Cellepora rostrata*, but I am now quite satisfied that they are all specifically identical.

(22) *Cellepora ovalis*, n. sp. (Pl. XXVIII. fig. 5, and Pl. XXXV. fig. 6).

Character.—Zoarium ramose, branches cylindrical, tapering. Zoœcia distinct, very prominent in the younger parts. Orifice orbicular, with a notch on one side. Pre-oral process strong, hollow, pointed, varying very much in height, and being much more prominent and pointed on the younger branches, than on the the main stem; it supports an avicularium with a wide triangular mandible, the beak simple. Oœcia subrecumbent, with two or three raised pores in front. Interspersed avicularia few, of an oval form.

Habitat.—Station 75, lat. 38° 37′ N., long. 28° 30′ W., 450 fathoms, sand (parasitic on a bundle of radical fibres of a Sertularian).

The labial notch in this case resembles that which occurs in most of the Retepores; it is not median but placed to one side, and appears to have a tendency to become converted into a sub-oral pore.

§§ *β. pisiform.*

(23) *Cellepora bicornis*, n. sp. (Pl. XXX. figs. 1 and 12, and Pl. XXXVI. figs. 13, 15).

Character.—Zoarium, globose. Zoœcia ventricose below, becoming tubular above. Orifice circular, notched (fig. 12 *a*); peristome much raised, tubular (fig. 12 *b*) and furnished in the perfect, sterile zoœcia with two cylindrical pre-oral processes, having on their summits minute avicularia, with acute, triangular mandible; besides these processes the peristome supports two to four spines, which in the perfect zoœcia are replaced by a decumbent globular oœcium (fig. 12 *c*), having a rounded fissure in front; the surface otherwise of the oœcium is smooth and polished. A very few interspersed avicularia (fig. 12 *d*) with an excessively delicate membranous mandible of a broadly lanceolate form.

Habitat.—Prince Edward Island, 80 to 150 fathoms. Marion Island, 50 to 75 fathoms. Station 150, lat. 52° 4′ S., long. 71° 22′ E., 150 fathoms, rock. Station 314, lat. 51° 36′ S., long. 65° 40′ W., 70 fathoms, sand and gravel. Station 313, lat. 52° 20′ S., long. 65° 40′ W., 55 fathoms (parasitic on *Myriozoum truncatum* and on *Onchopora sinclairii*).

(24) *Cellepora bilabiata*, n. sp. ? (Pl. XXX. fig. 2).

Character.—Zoarium pisiform, very minute. Zoœcia very irregularly disposed erect, pitcher-shaped. Mouth circular, emarginate (fig. 2*a*); peristome thick and often produced into a rather deep, bilabiate cup (fig. 2*b*). In some zoœcia, a short strong, conical pre-oral process. Oœcia (fig. 2*c*) small, spherical, recumbent.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand (parasitic on *Amathea spiralis*).

The collection affords only one or two small specimens scarcely sufficient for the purpose of diagnosis.

(25) *Cellepora signata*, n. sp. (Pl. XXX. fig. 3, and Pl. XXXVI. fig. 14).

Character.—Zoarium pisiform. Zoœcia deeply immersed and very confusedly arranged; surface smooth, shining. Orifice (fig. 3*b*) arcuate, with a straight lower lip, having a very minute median notch. A strong, curved, hollow pre-oral rostrum, with an avicularium on its posterior aspect near the summit, with a short, obtuse, spatulate mandible pointing upwards. A few large, interspersed avicularia (fig. 3*d*) with broad, spatulate mandible. Oœcium (fig. 3*c*) erect, flattened in front, on which is a semicircular area punctured (not grooved) round the border.

Habitat.—Station 304, lat. 46° 53′ S., long. 75° 11′ W., 45 fathoms, sand (parasitic on a Sertularian).

(26) *Cellepora conica*, n. sp. ? (Pl. XXVIII. fig. 10, and Pl. XXXVI. fig. 1).

? *Cellepora avicularis*, Smitt, Florid. Bryoz. p. 53, pl. ix. figs. 193–197.

Character.—Zoarium in small conical lobes; 0″·125 to 0″·16, disposed more or less in a stelliform manner. Zoœcia with a slightly rugose surface, and in the very young ones obscurely punctured. Orifice clithridiate, peristome rather thick, sometimes raised on one or both sides. A cylindrical short curved pre-oral rostrum, with a terminal avicularium, with a semicircular mandible. A few interspersed retentive avicularia of small size, with spatulate mandible. Oœcia small spherical, deeply immersed, punctured all over.

Habitat.—Simon's Bay, Cape of Good Hope (parasitic on a Sertularian).

I have little doubt that this is the young state of the form described by Prof. Smitt (*loc. cit.*) as *Cellepora avicularis*, but I much doubt whether it is identical with the *Cellepora avicularis* of Hincks, which is of much larger growth, and consequently it is not the *Cellepora avicularis*, Smitt, as represented in specimens from Spitzbergen, which latter is Mr. Hincks' species.

(27) *Cellepora ansata*, n. sp. (Pl. XXX. fig. 4, and Pl. XXXVI. fig. 17).

Character.—Zoarium in the form of small stellate growths or tufts, having three or four conical, pointed divisions. Zoœcia deeply immersed at the base, but more free and erect above; surface shining, rugose. Orifice circular, notched; peristome in the older zoœcia produced in front and on the sides into a long, tubular or rather canalicular process, which supports on each side a small avicularium with a semicircular mandible. Numerous interspersed retentive avicularia, with curved, spatulate, membranous mandible.

Habitat.—Station 75, lat. 38° 37′ N., long. 28° 30′ W., 450 fathoms, sand (parasitic on a small Sertularian ?)

(28) *Cellepora canaliculata*, n. sp. (Pl. XXX. fig. 5, and Pl. XXXVI. fig. 16).

Character.—Zoarium pisiform. Zoœcia ventricose, tolerably distinct; surface rough, entire. Orifice orbicular and notched in front, or more usually clithridiate. A strong curved pre-oral rostrum, from which a thin expansion is continued on each side of the mouth so as to form a spacious spout-like cavity, at the bottom of which the mouth is situated; on the posterior aspect of the rostrum, near the summit, is an avicularium with a semicircular mandible; the apical portion of the process is cylindrical.

Habitat.—Station 48, lat. 43° 2′ N., long. 64° 2′ W., 51 fathoms, rock.

(29) *Cellepora bidenticulata* (Pl. XXX. fig. 6, and Pl. XXXVI. fig. 6).

Character.—Zoarium small, pisiform. Zoœcia ventricose, walls thin, sparsely punctured. Orifice (fig. 6*a*) subclithridiate, with two very minute denticles within the lower border; peristome in the older zoœcia (fig. 6*b*) raised on one side into a thin canalicular expansion and on the opposite side into a thicker process which supports on its inner face a rather large avicularium, with a triangular, obtuse mandible.

Habitat.—Station 163B, off Port Jackson, 35 fathoms, hard ground (parasitic on a Sertularian).

Var. *a. subæqualis* (Pl. XXXVI. fig. 11) (chitinous parts).

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

Differs from the form represented in the specimens from Station 163A in the smaller size of the operculum, which is pretty nearly of the same dimensions as the oral avicularian mandible.

(30) *Cellepora granum*, Hincks (Pl. XXXVI. fig. 10) (chitinous parts).

Cellepora granum, Hincks, Ann. and Mag. Nat. Hist., ser 5, vol. viii. p. 68, pl. iii. fig. 8, 1881.

Character.—Zoœcia ovoid, smooth, distant. Orifice suborbicular with a pointed sinus; peristome raised all round and produced in front into a median rostrum supporting an avicularium on its inner face. Oœcia globose, smooth, with semicircular perforated area in front. A few interspersed retentive avicularia, with a broad, spatulate and cucullate mandible.

Habitat.—Station 162, off East Moncœur Island, Bass Strait, 38 fathoms, sand and shells.

[Off Curtis Island, abundant, Hincks.]

Only one or two small specimens, in poor condition, occur in the collection, but sufficient to show that in all probability they represent Mr. Hincks' form, in whose figure the peculiar position of the oœcium is well shown.

(31) *Cellepora tubulosa*, Hincks (sp. ?).

Cellepora costazii, var. *a*, *tubulosa*, Hincks, Brit. Mar. Polyz., vol. i. p. 411, pl. lv. fig. 13.

Character.—Zoarium globose; zoœcia of two forms, one ventricose, immersed below, primary orifice pyriform, peristome thin, even with the surface; the other having the peristome much produced and tubular, a cylindrical hollow process on each side which supports at the apex a small avicularium, with an acutely pointed mandible. Secondary orifice large, subquadrangular, the border undulated, one face of the tubular process hollowed, the other rounded. Oœcia recumbent, with a circular finely punctate area on the upper face, placed near the base of the tubular process on the hinder (?) aspect, and above it usually a large triangular opening. Surface generally smooth and entire. Operculum pyriform, pointed below, with an even margin; avicularian mandible subacicular or acuminate.

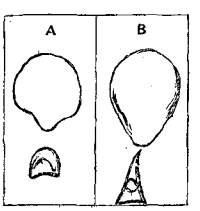


FIG. 59.—A. Operculum and mandible of *Cellepora hassallii*. B. Operculum and mandible of *Cellepora tubulosa*.

Habitat.—Stations 135A and C, Nightingale and Inaccessible Islands, Tristan da Cunha, 75 and 110 fathoms.

Though it is by no means certain that the form here described is identical with Mr. Hincks' var. *a* of *Cellepora costazii* seu *hassallii*; there can be no doubt that the two are very closely allied, nor that they stand in close relation to the form figured by Savigny (Egypte, pl. vii. fig. 4), whether that be identical with the British *Cellepora hassallii*, as Mr. Hincks supposes, or not. At the same time it is quite clear that *Cellepora tubulosa* is distinct from the typical *Cellepora hassallii*, with which I have carefully compared it.

Leaving out of the question the tubular production of the peristome and the globose pisiform habit, &c., the differences in the chitinous elements alone are quite sufficient to show their specific distinctness. In *Cellepora tubulosa* the operculum is simply pyriform, exactly corresponding with the orifice, whilst in *Cellepora hassallii* it is suborbicular with a short peduncular projection below corresponding to the abrupt emargination of the lower border of the orifice; and the avicularian mandibles in the former are acutely pointed or subacicular and in the latter semicircular, as in the great majority of Cellepores.

Family XXXIII. Selenariadæ.

Selenariadæ, Brit. Mus. Cat., part I. p. 97.
Selenaridea, Manzoni.
Escharidæ (pars), d'Orb.
Cellariœa (pars), Blainv.
Membraniporidæ and *Microporidæ* (sp.), Smitt.

Character.—Zoarium orbicular or irregular in outline, convex on one side, plane or concave on the other, in the mature state probably free, often with a foreign particle central or eccentric on the concave face. Zoœcia immersed, flustrine.

The Family here contains the following genera:—

1. *Cupularia*, Lamouroux.
   (1) *Cupularia guineensis*, Busk (Pl. XIV. fig. 6).
   (2) *Cupularia monotrema*, n. sp. (Pl. XIV. fig. 5).
   (3) *Cupularia owenii*, Gray.
2. *Lunularia*, Lamouroux (*nom. mut.*)
   (1) *Lunularia capulus*, Busk (Pl. XIV. fig. 7).

1. *Cupularia*, Lamouroux.

Cupularia, Lamx., Brit. Mus. Cat., p. 97.
Lunulites (pars), Defrance & Auctt.
Fenestella (pars), Lonsdale.

Character.—Each zoœcium having a vibracularium at its apex.

(1) *Cupularia guineensis*, Busk (Pl. XIV, fig. 6).

Cupularia guineensis, Bk., Brit. Mus. Cat., I., p. 98, pl. cxiv.

Character.—Zoarium orbicular, in section crescentic; area rhomboidal, orifice ovoid, not extending to the summit; lamina and raised border finely granular, edge of aperture entire. Vibracular opening auricular, with small elevation on one side. Under surface, with shallow radial sulci, ridges quite flat, divided into moveable quadrangular areas, each of which has four or five shallow pits.

Habitat.—Station 186, lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms, coral sand.

[New Guinea; Philippine Islands, Voy. of Rattles.]

A single dead specimen, but not worn. In the Brit. Mus. Cat. the dorsal surface is described and figured as being divided into hexagonal areas, and the surface as verrucose. But in the older condition, probably, as in the Challenger specimen, the dorsal surface is very finely sulcate, and the areas into which it is subdivided are more or less quadrangular, but in most parts of unequal size. The pits with which the areas are furnished appear to be quite shallow, but they may represent occluded pores, in which case the dorsal aspect would bear some resemblance to that of *Cupularia canariensis*, Busk. In other respects, however, the distinction between the two species is sufficiently obvious.

(2) *Cupularia monotrema*, n. sp. (Pl. XIV. fig. 5).

Character.—Zoarium orbicular, depressed, about 0″·5 in diameter. Area pyriform; orifice linear narrow, with entire edges. Oral valve epidermic, elongated hippocrepian, broad at the base. Vibracular opening large, auricular, with a large tooth on one side, and a rather wide sinus. Occasionally a zoœcium is converted into a prominent avicularium with an acuminate mandible pointing downwards, and a wide cup-shaped beak. Dorsal surface divided into square areas, each with a central perforation.

Habitat.—Off Bahia, 10 to 20 fathoms.

This form is distinguished from all its congeners known to me by the circumstance that many zoœcia are transformed into avicularia. The only specimen is covered with its epidermis or epitheca, so that the exact conformation of the lamina cannot be seen, but it would appear to be of an elongated narrow shape. The oral valve as shown in the figure is placed quite at the summit of the zoœcium; it is surrounded by a thick chitinous frame, and is not articulated to any part of the calcareous skeleton. The peculiar characters of the dorsal surface cannot be seen unless the epidermic covering be removed, as shown in the figure.

(3) *Cupularia owenii*, Gray, sp.

Lunulites owenii, Gray, Spicilegia Zool., pt i. p. 8, pl. iii. fig. 15.
Cupularia owenii, Bk., Brit. Mus. Cat., II. p. 99, pl. cxv.
„ *denticulata* (?), Conrad; Lonsdale; Bk., Crag Polyzoa, p. 85, pl. xiii. fig. 1.
Lunulites alveolatus (?), S. Wood, Ann. and Mag. Nat. Hist., vol. xiii. p. 18.

Habitat.—St. Vincent, Cape Verde Islands, 11 fathoms, mud.
[Coast of Africa; Canaries, M'Andrew.]

2. *Lunularia*, Lamouroux (*nomen mutatum*).

Lunulites, Lamouroux, 1821, Brit. Mus. Cat., part i. p. 100; (pars) Lamarck, Defrance, &c.

Character.—Zoœcia disposed in series, radiating from the centre and bifurcating as they advance towards the border; the vibracularia lying in linear series, alternating with those of the zoœcia. The chitinous vibraculum usually bifid or trifid at the extremity.

In order to avoid the confusion attending the name *Lunulites*, which has usually been understood, by the older writers at any rate, more as a family than as a generic appellation, and is moreover more suitable, in conformity with general usage, for fossil forms, I propose to change it for *Lunularia*, the termination of which is also more in accordance with the other genera in the same family.

(1) *Lunularia capulus*, Busk (Pl. XIV. fig. 7).

Lunulites capulus, Bk., Brit. Mus. Cat., vol. i., p. 100, pl. cxii., and Voy. of Rattles., I., pl. i. figs. 13, 14.

Character.—Zoarium rounded, conical, much raised; area semilunar or arched above, and straight below with a small bifid denticle within the margin (sometimes not seen); margin granular; vibracula trifid at the extremity. Dorsal surface grooved; ridges punctured with a single row of pores.

Habitat.—Station 161, off Port Philip, 33 fathoms, sand.

[Off Cape Capricorn, Voy. of Rattles.]

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PLATE I.

PLATE I.

CATENICELLA.

PAGE

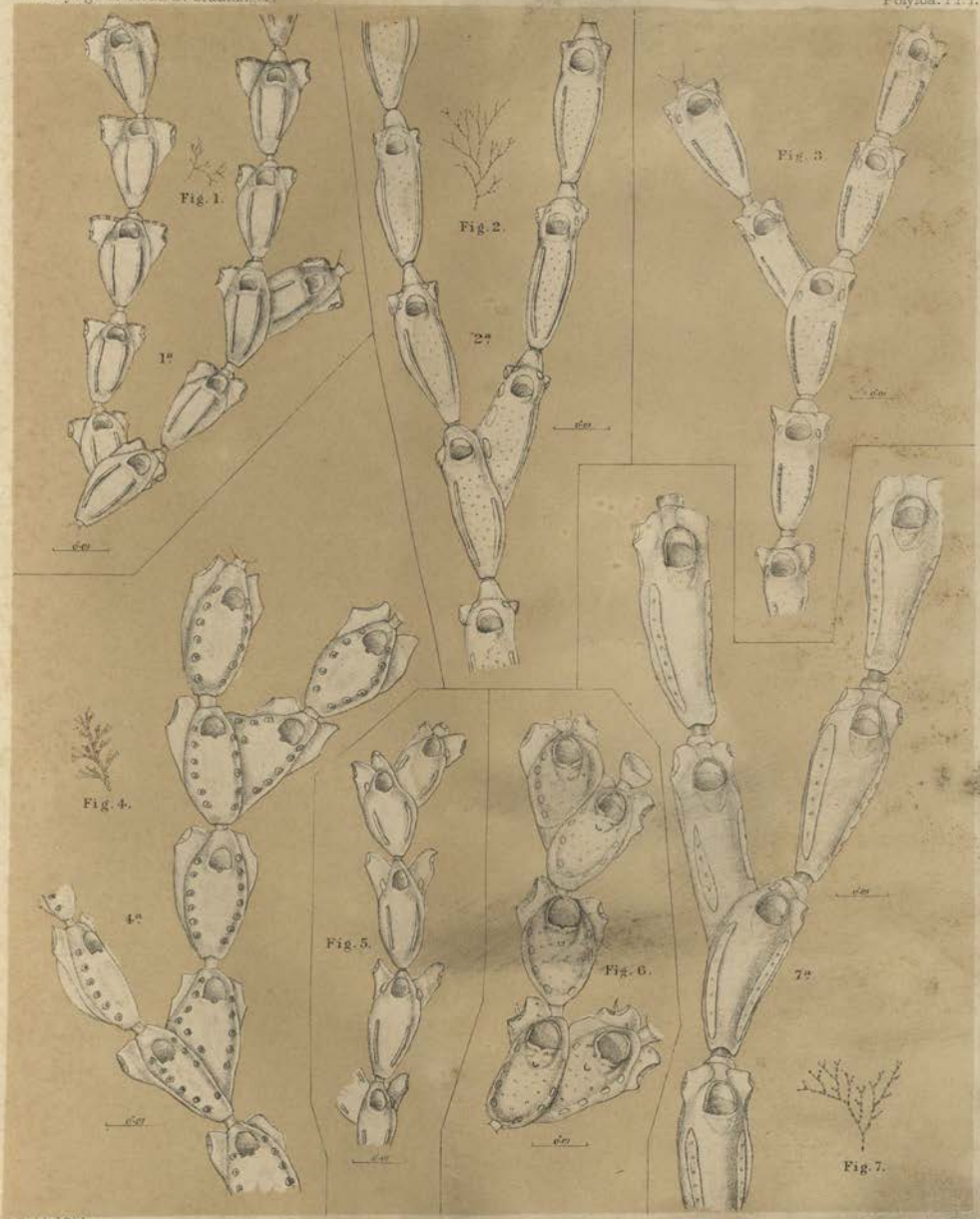
Figure 1.—*Catenicella umbonata*, ... 13
1*a*, magnified.

„ 2, 3, 5.—*Catenicella elegans*, ... 12
2*a*, 3, 5, magnified.

„ 4.—*Catenicella pulchella*, ... 13
4*a*, magnified.

„ 6.—*Catenicella cribraria*, ... 11

„ 7.—*Catenicella sacculata*, ... 12
7*a*, magnified.



1. CATENICELLA UMBONATA. 2. 3. 5. C. ELEGANS.
4. C. PULCHELLA. 6. C. CRIBRARIA. 7. C. SACCULATA.

PLATE II.

PLATE II.

CATENARIA.—CELLULARIA.

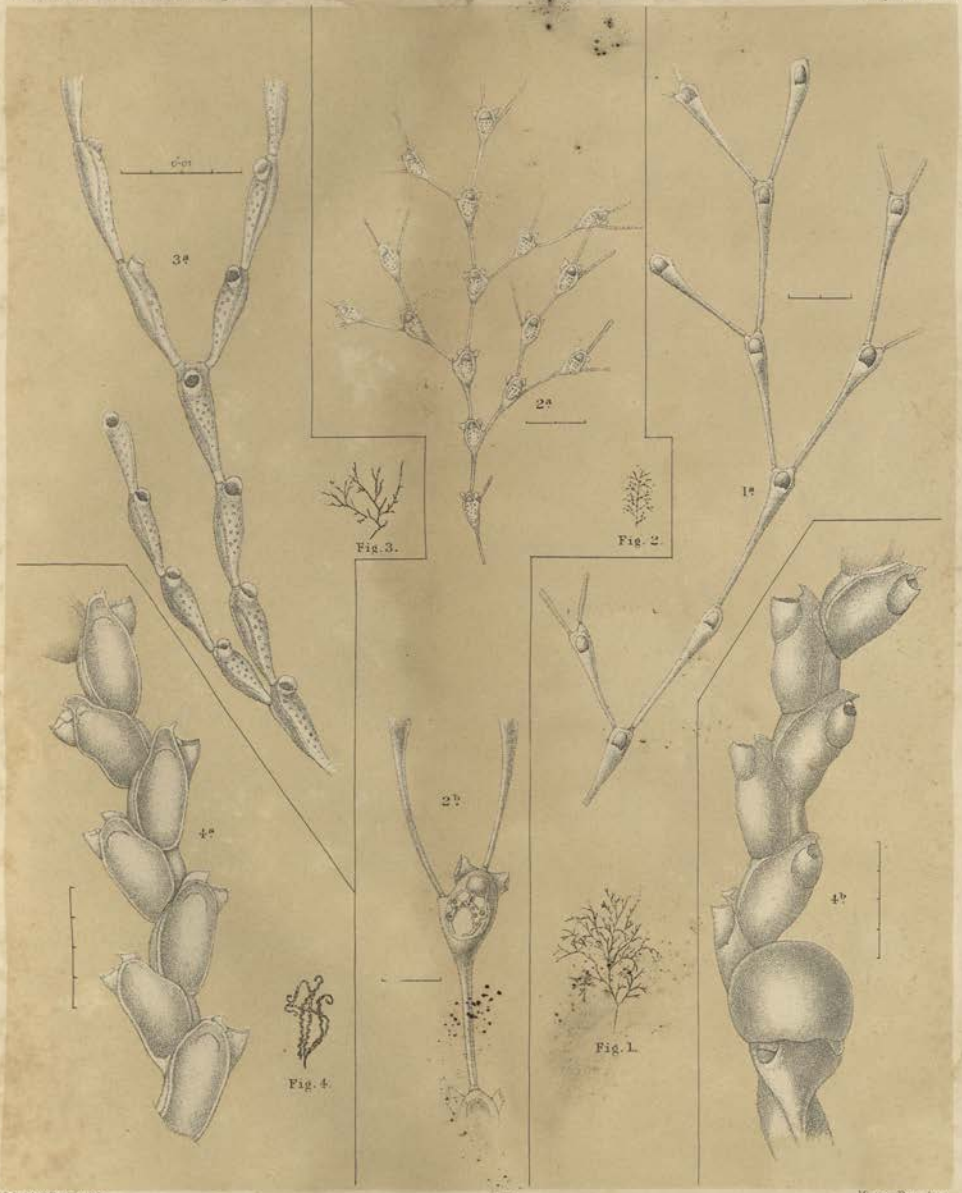
PAGE

Figure 1.—*Catenaria attenuata*, ... 14
1*a*, magnified.

„ 2.—*Catenaria bicornis*, ... 14
2*a*, magnified; 2*b*, more highly magnified.

„ 3.—*Catenaria diaphana*, ... 14
3*a*, magnified.

„ 4.—*Cellularia cirrata*, ... 17
4*a*, magnified; 4*b*, with oœcium.



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1. CATENARIA ATTENUATA. 2. C. BICORNIS.
3. C. DIAPHANA. 4. CELLULARIA CIRRATÆ.

PLATE III.

PLATE III.

CELLULARIA.—BUGULA.

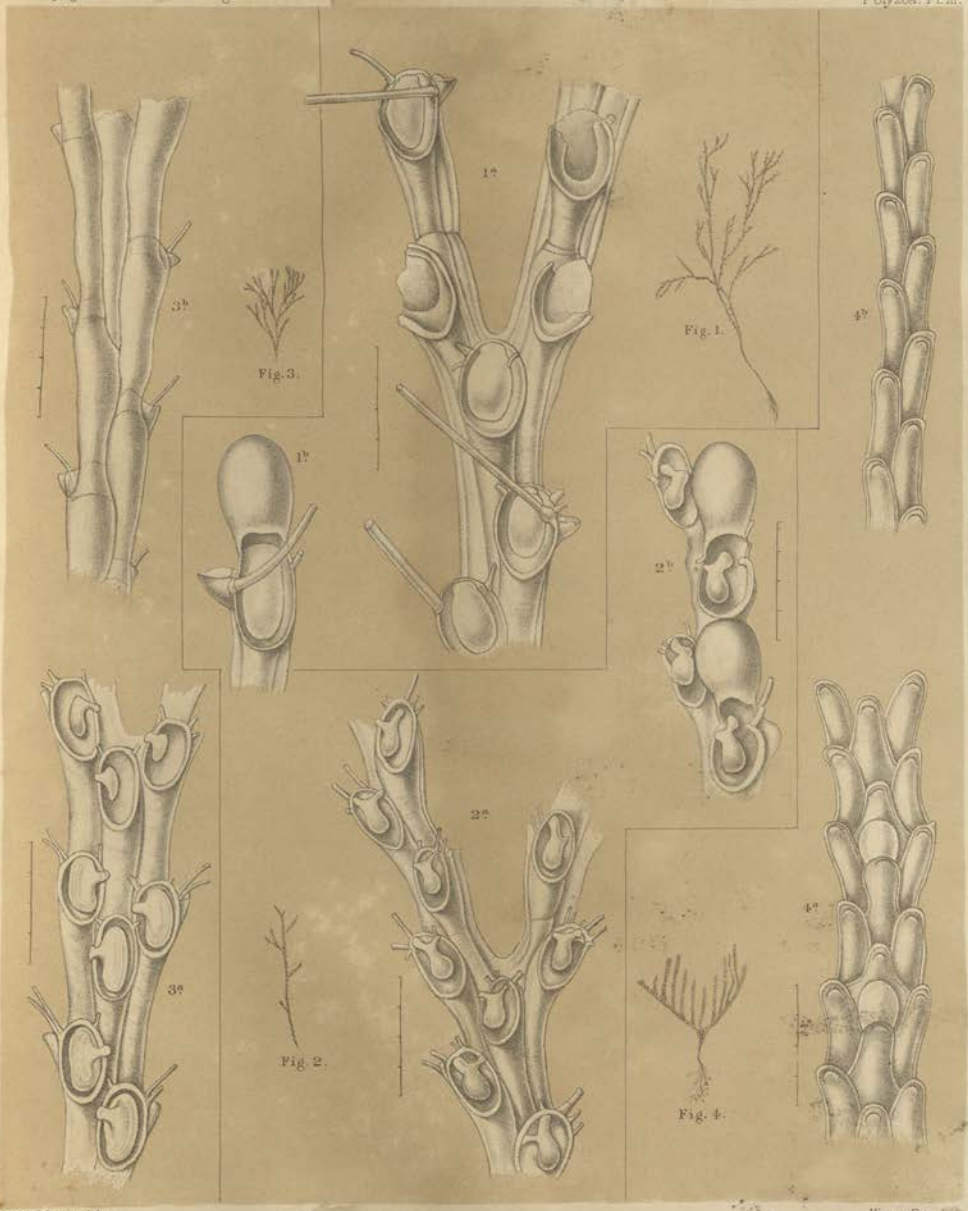
PAGE

Figure 1.—*Cellularia crateriformis*, ... 16
1*a*, magnified; 1*b*, with oœcium.

„ 2.—*Cellularia biloba*, ... 18
2*a*, magnified; 2*b*, with oœcia.

„ 3.—*Cellularia elongata*, ... 19
3*a*, magnified; 3*b*, back view.

„ 4.—*Bugula versicolor*, ... 38
4*a*, magnified; 4*b*, with oœcia.



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1. CELLULARIA CRATERIFORMIS. 2. C. BILOBA.
3. C. ELONGATA. 4. BUGULA VERSICOLOR.

PLATE IV.

PLATE IV.

MENIPEA.

PAGE

Figure 1.—*Menipea flagellifera*, ... 21
1*a*, 1*b*, magnified.

„ 2.—*Menipea aculeata*, ... 20
2*a*, magnified.

„ 3.—*Menipea marionensis*, ... 21
3*a*, magnified (Pl. XIV. fig. 9).

„ 4.—*Menipea benemunita*, ... 19
4*a*, magnified.

„ 5.—*Menipea clausa*, ... 20
5*a*, magnified.

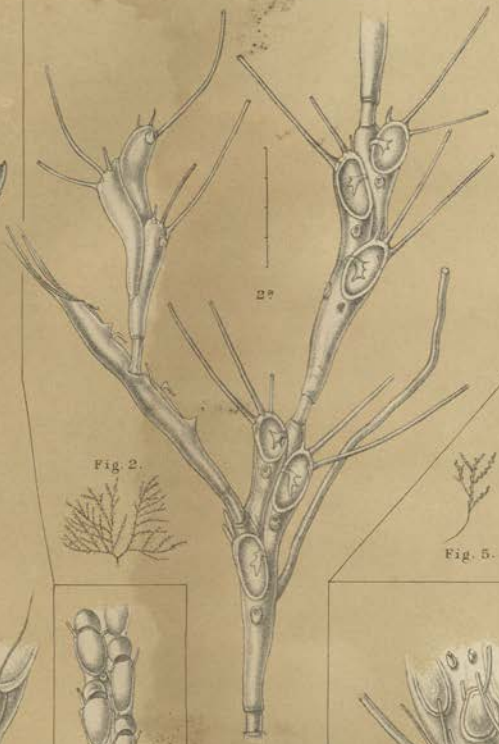


Fig. 2.

Fig. 5.

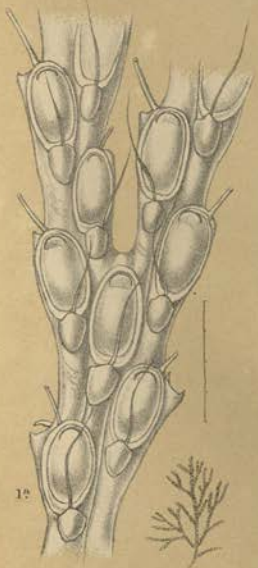


Fig. 1.

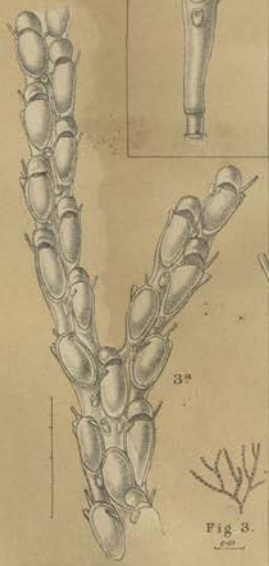


Fig. 3.

Fig. 4.

G.B. del. C. Berjeau lith. Mintern Bros. imp.

1. MENIPEA FLAGELLIFERA. 2. M. ACULEATA.
3. M. MARIONENSIS. 4. M. BENEMUNITA. 5. M. CLAUSA.

PLATE V.

PLATE V.

FARCIMINARIA.—MENIPEA.—CELLULARIA.—NELLIA.

PAGE

Figure 1.—*Farciminaria magna*, ... 49
1*a*, magnified; 1*b*, with oœcia; more highly magnified.

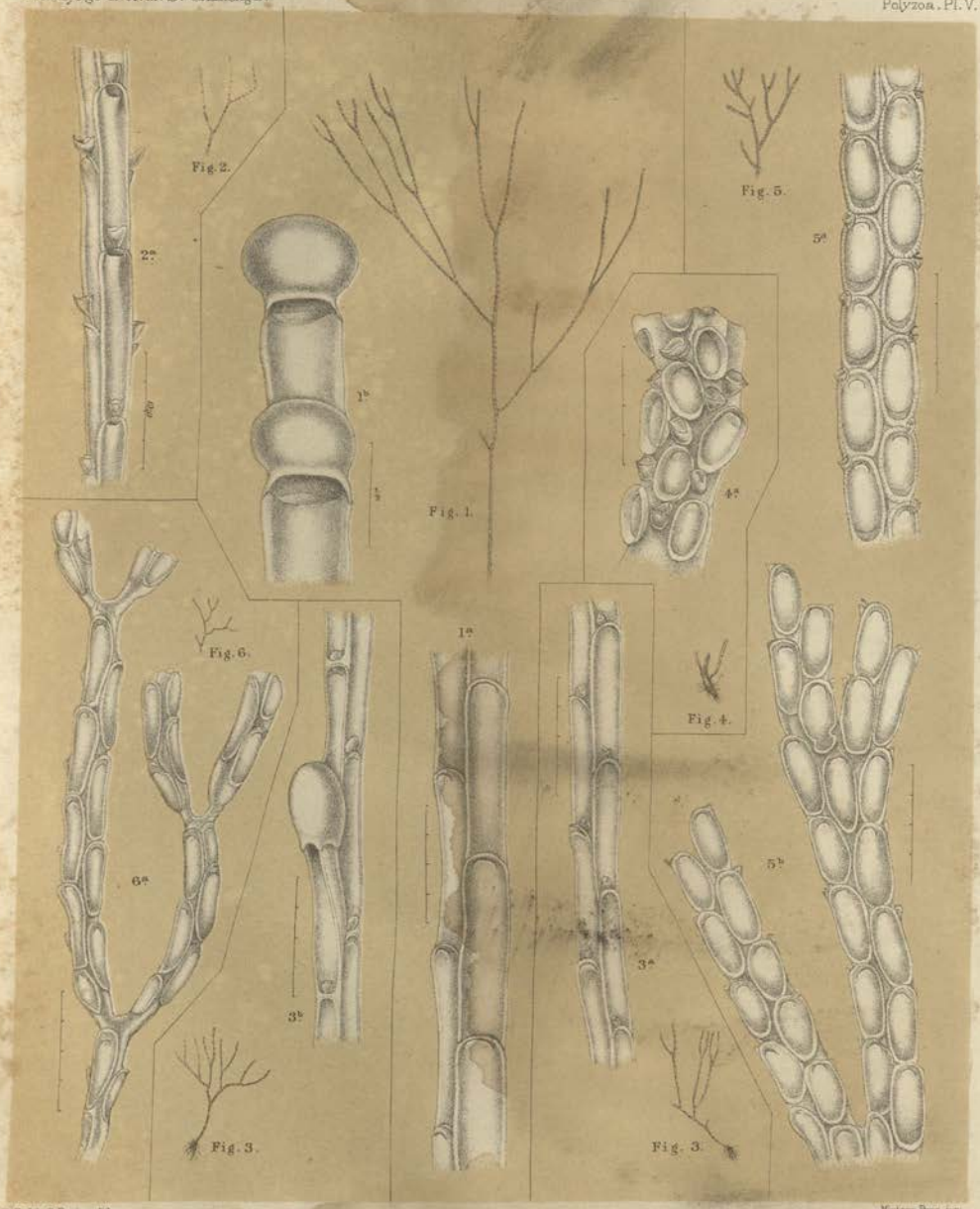
„ 2.—*Farciminaria cribraria*, ... 49
2*a*, magnified.

„ 3.—*Farciminaria gracilis*, ... 51
3*a*, magnified; 3*b*, with oœcium.

„ 4.—*Menipea pateriformis*, ... 22
4*a*, magnified.

„ 5.—*Cellularia quadrata*, ... 18
5*a*, magnified; 5*b*, back view.

„ 6.—*Nellia simplex*, ... 27
6*a*, magnified.



G.B. del. C. Berjeau lith.

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1. FARCIMINARIA MAGNA. 2. F. CRIBRARIA. 3. F. GRACILIS.
4. MENIPEA PATERIFORMIS. 5. CELLULARIA QUADRATA. 6. NELLIA SIMPLEX.

PLATE VI.

PLATE VI.

Bicellaria.

PAGE

Figure 1.—*Bicellaria glabra*,[1] 35
1*a*, magnified.

„ 2.—*Bicellaria infundibulata*, ... 33
2*a*, side view, magnified; 2*b*, back view; 2*c*, 2*d*, avicularia, more highly magnified.

„ 3.—*Bicellaria bella*, ... 34
3*a*, oœcium; 3*b*, avicularium.

„ 4.—*Bicellaria moluccensis*, ... 34

[1] Since this plate was printed, Mr. Hincks having described the same form under the name of *Stirparia glabra*, I have adopted his specific appellation.

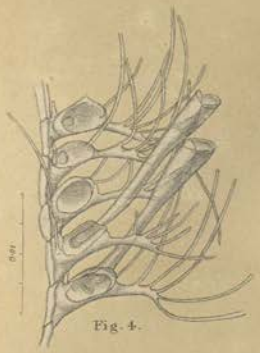


Fig. 4.

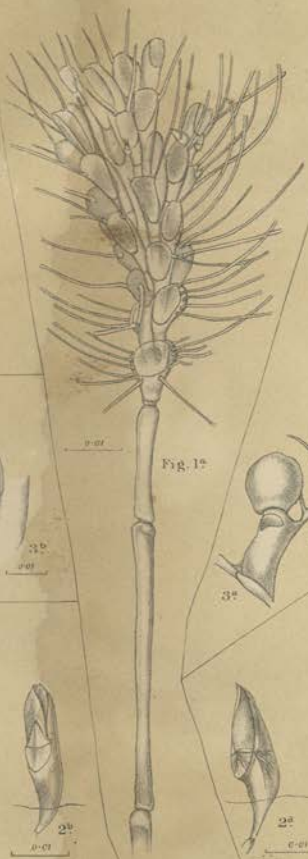


Fig. 1a

Fig. 3.

3b

3a

2a

2b

2c

2d

Fig. 2.

Fig. 1.

G. B. del. C. Berjeau lith. Mintern Bros. imp.

1. BICELLARIA STYLITES. 2. B. INFUNDIBULATA.
3. B. BELLA. 4. B. MOLUCCENSIS.

PLATE VII.

PLATE VII.

BICELLARIA.

PAGE

Figure 1.—*Bicellaria pectogemma*,[1] 33
1*a*, magnified; 1*b*, 1*c*, avicularia, more highly magnified.

,, 2.—*Bicellaria navicularis*, ... 32
2*a*, magnified; 2*b*, oœcium.

[1] Mr. Goldstein having, since the plate was printed several years ago, given another name to this species, I have accordingly adopted it.

G.B. del. C. Berjeau lith. Mintern Bros., imp.

1. BICELLARIA SPATULATA. 2. B. NAVICULARIS.

PLATE VIII.

PLATE VIII.

KINETOSKIAS.—BUGULA.

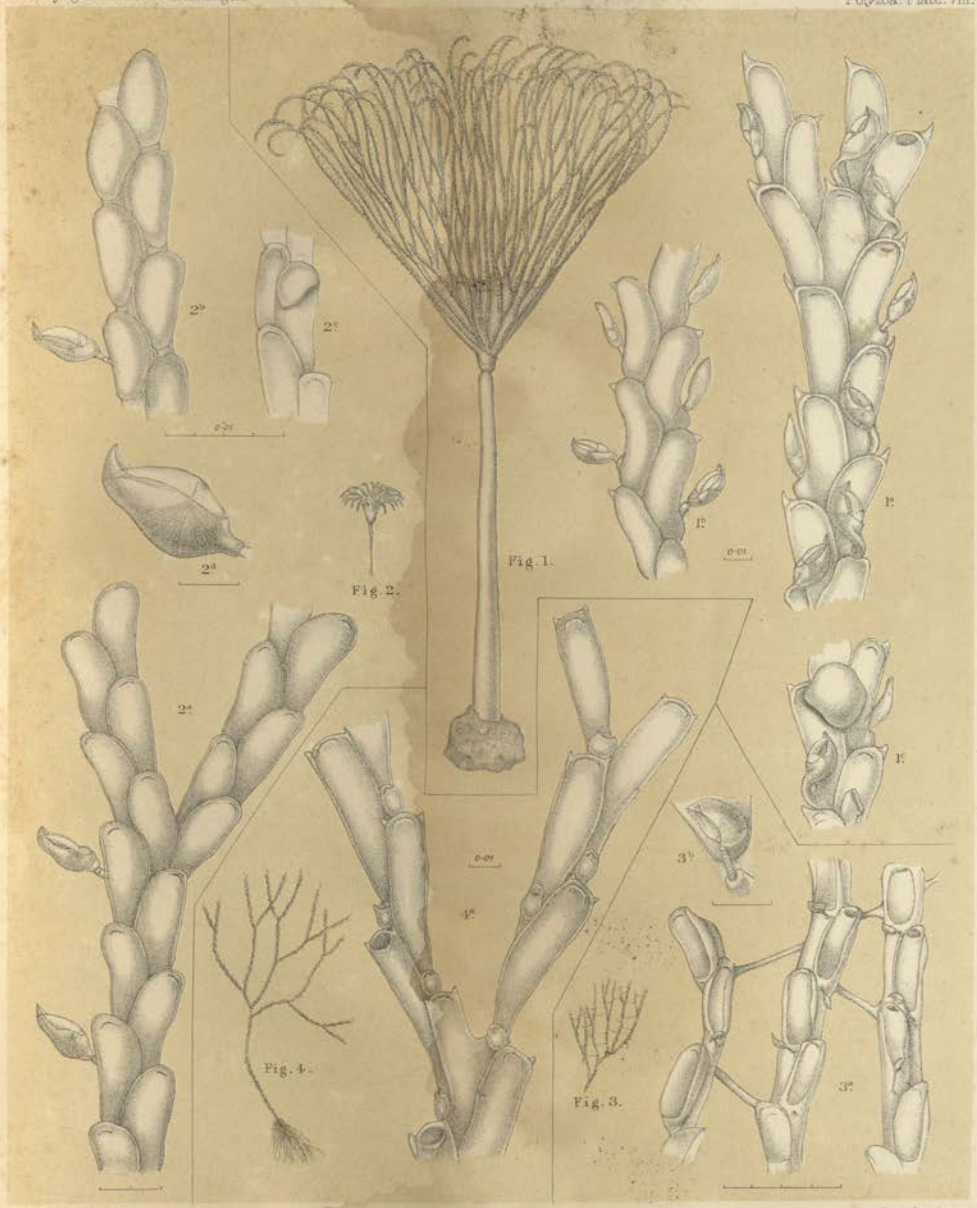
PAGE

Figure 1.—*Kinetoskias cyathus* (after Sir C. Wyville Thomson), . . 44
1*a*, magnified; 1*b*, back view; 1*c*, œcium.

„ 2.—*Kinetoskias pocillum*, ... 45
2*a*, magnified; 2*b*, back view; 2*c*, œcium; 2*d*, avicularium, more highly magnified.

„ 3.—*Bugula reticulata*, ... 40
3*a*, magnified; 3*b*, avicularium.

„ 4.—*Bugula margaritifera*, ... 41
4*a*, magnified.



C.B. del. C.Berjeau lith. Mintern Bros. imp.

1. KINETOSKIAS CYATHUS. 2. K. POCILLUM.
3. BUGULA RETICULATA. 4. B. MARGARITIFERA.

PLATE IX.

PLATE IX.

Bugula.

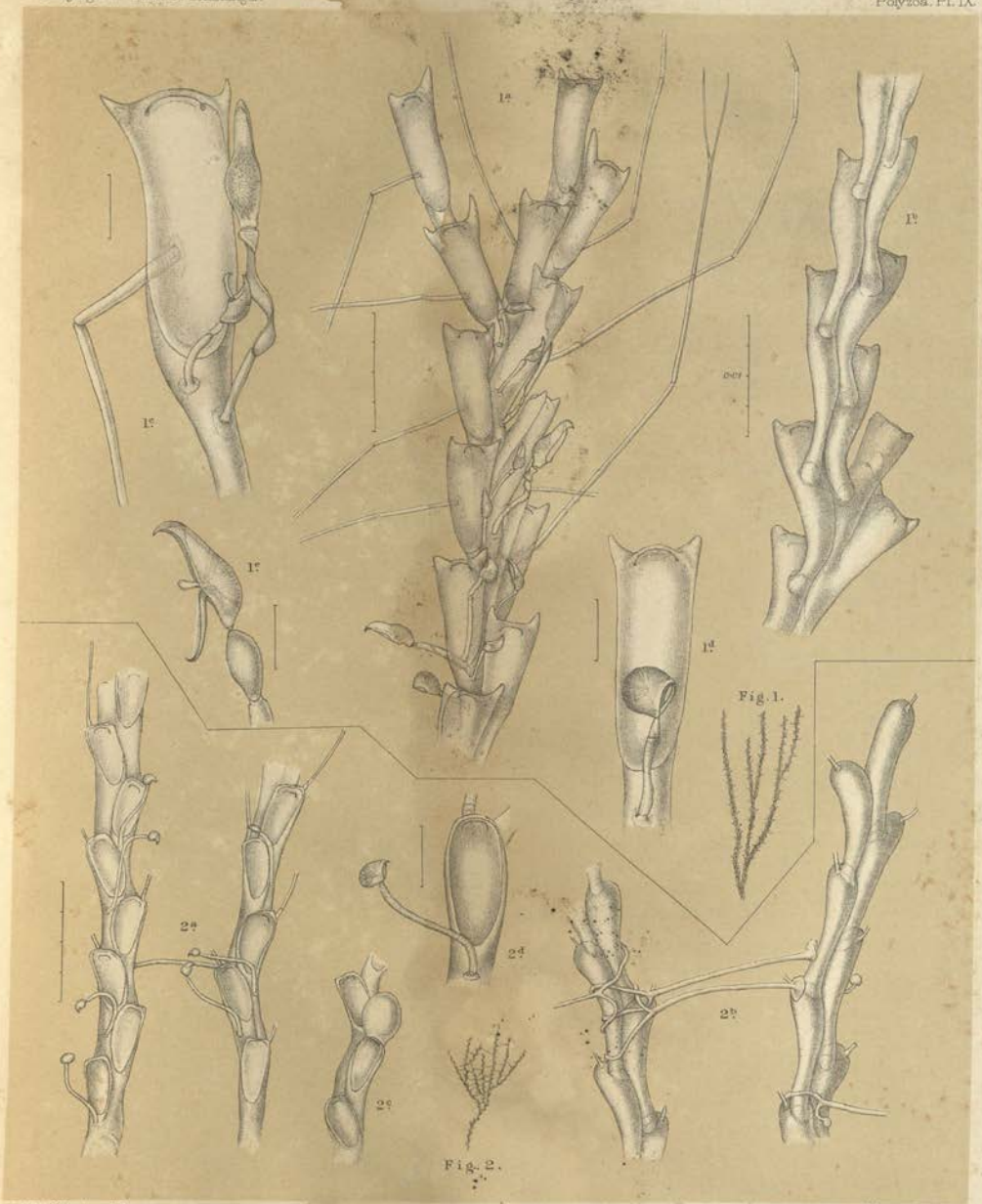
PAGE

Figure 1.—*Bugula bicornis*, ... 40

1*a*, magnified; 1*b*, back view; 1*c*, two avicularia and radical tube; 1*d*, smaller avicularium arising close below the aperture; 1*e*, larger avicularium, showing the digitiform process.

,, 2.—*Bugula reticulata*, var. *unicornis*, ... 40

2*a*, magnified; 2*b*, back view; 2*c*, oœcium; 2*d*, avicularium.



G.B. del. C.Berjeau lith.

Mintern Bros. imp.

1. BUGULA BICORNIS. 2. B. RETICULATA, *VAR.* UNICORNIS.

PLATE X.

PLATE X.

BUGULA.—ONCHOPORA.

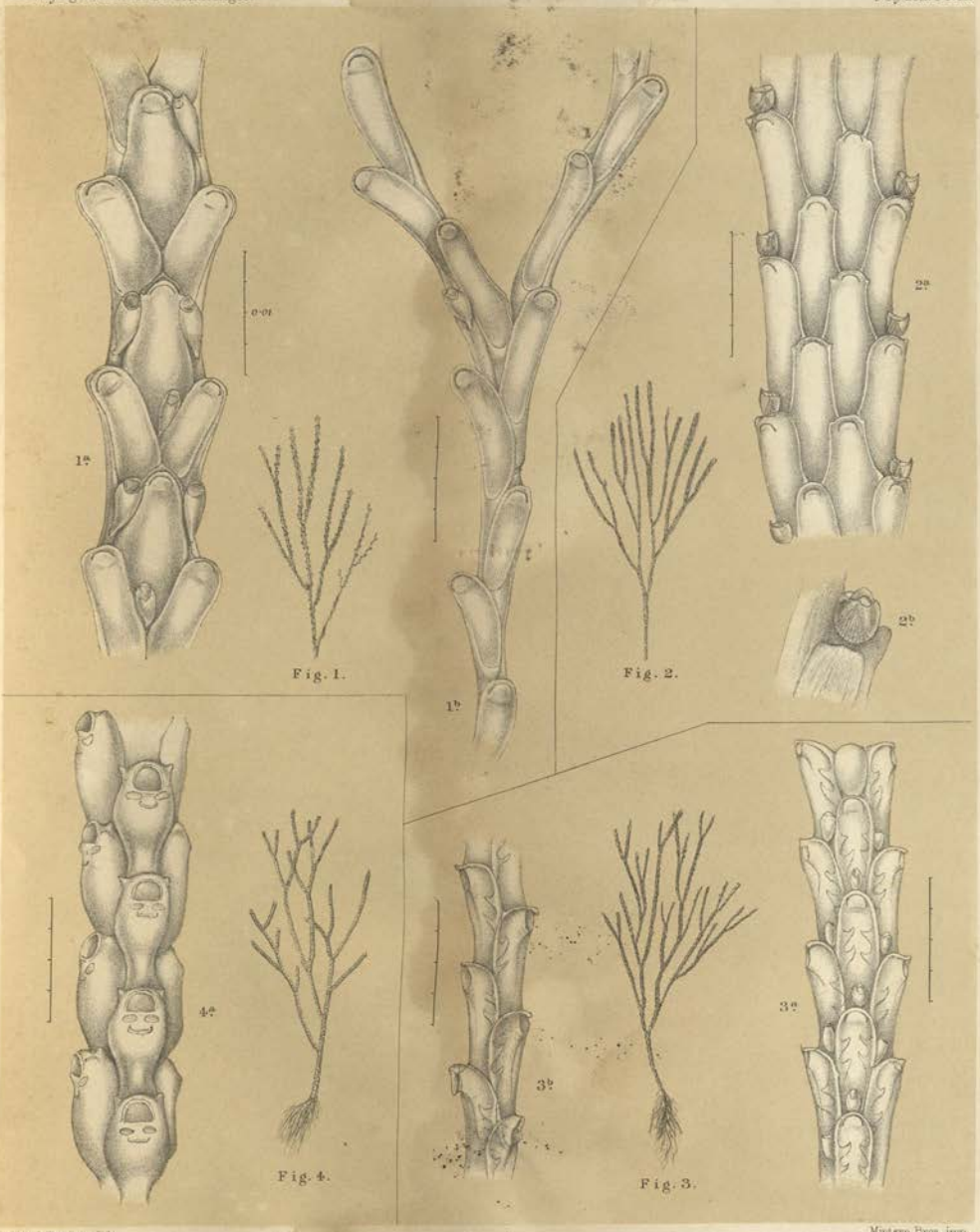
PAGE

Figure 1.—*Bugula mirabilis*, ... 39
1*a*, upper or triserial portion; 1*b*, lower or biserial portion.

„ 2.—*Bugula sinuosa*, ... 39
2*a*, magnified; 2*b*, avicularium.

„ 3.—*Bugula leontodon*, ... 39
3*a*, triserial portion; 3*b*, biserial portion.

„ 4.—*Onchopora sinclairii*, ... 103
4*a*, magnified.



G B del. C Berjeau lith. Mintern Bros., imp.

1. BUGULA MIRABILIS. 2. B. SINUOSA.
3. B. LEONTODON. 4. ONCHOPORA SINCLAIRII.

PLATE XI.

PLATE XI.

CABEREA.—SCRUPOCELLARIA.

PAGE

Figure 1.—*Caberea crassimarginata*, ... 28
1*a*, magnified; 1*b*, back view.

„ 2.—*Scrupocellaria securifera*, ... 24
2*a*, magnified; 2*b*, back view.

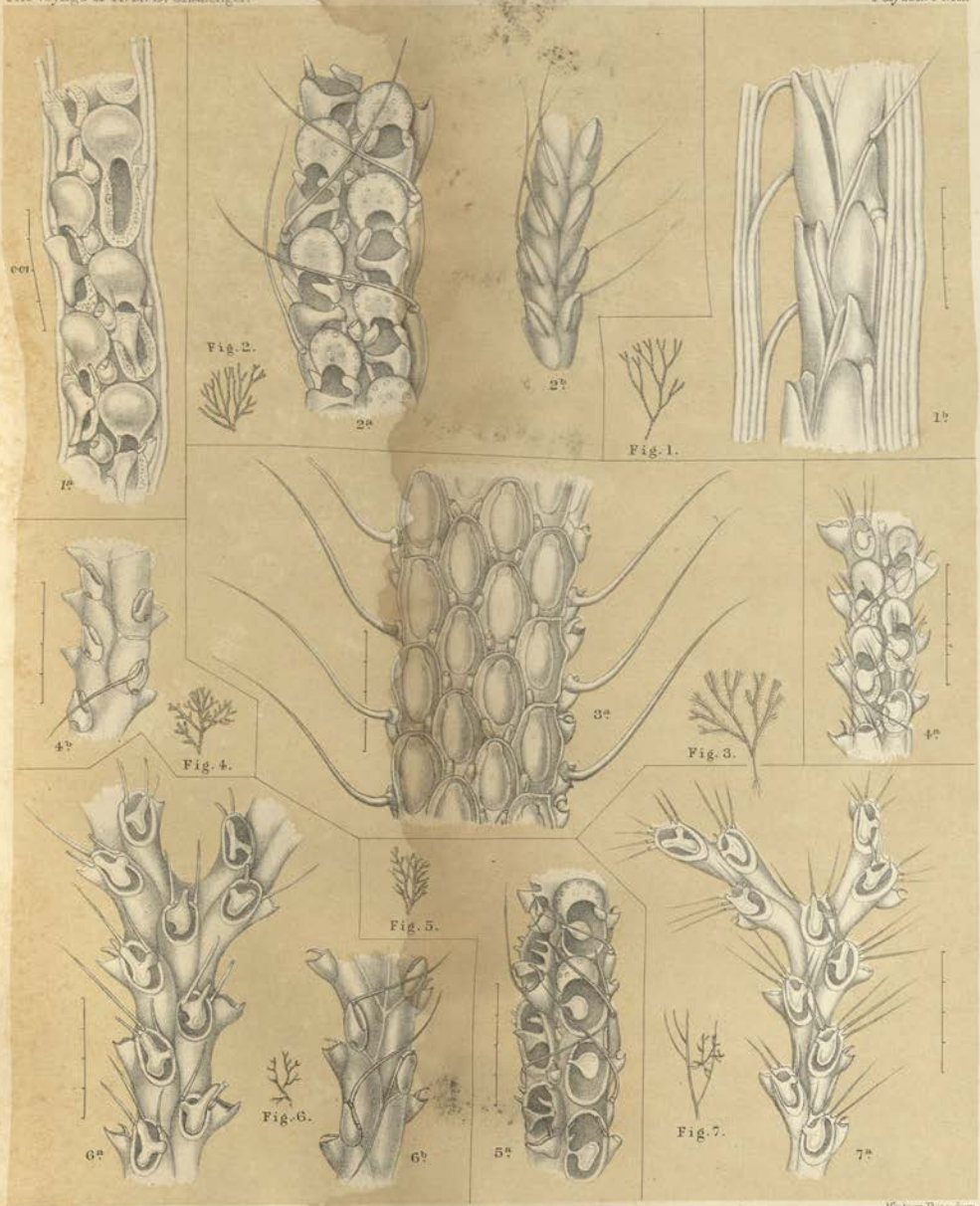
„ 3.—*Caberea lata*, ... 30
3*a*, magnified.

„ 4.—*Scrupocellaria macandrei*, ... 23
4*a*, magnified; 4*b*, back view.

„ 5.—*Scrupocellaria ciliata*, ... 23
5*a*, magnified.

„ 6.—*Scrupocellaria ornithorhynchus*, ... 24
6*a*, magnified; 6*b*, back view.

„ 7.—*Scrupocellaria pilosa*, ... 24
7*a*, magnified.



G.B. del. C.Berjeau lith.

Mintern Bros., Imp.

1. CABEREA CRASSIMARGINATA. 2. SCRUPOCELLARIA SECURIFERA. 3. CABEREA LATA.
4. SCRUPOCELLARIA MACANDREI. 5. S. CILIATA. 6. S. ORNITHORHYNCHUS. 7. S. PILOSA.

PLATE XII.

PLATE XII.[1]

SALICORNARIA.

PAGE

Figures 1, 5, 7.—*Salicornaria malvinensis,** 91
1*a*, 1*b*, 5*a*, 7*a*, magnified.

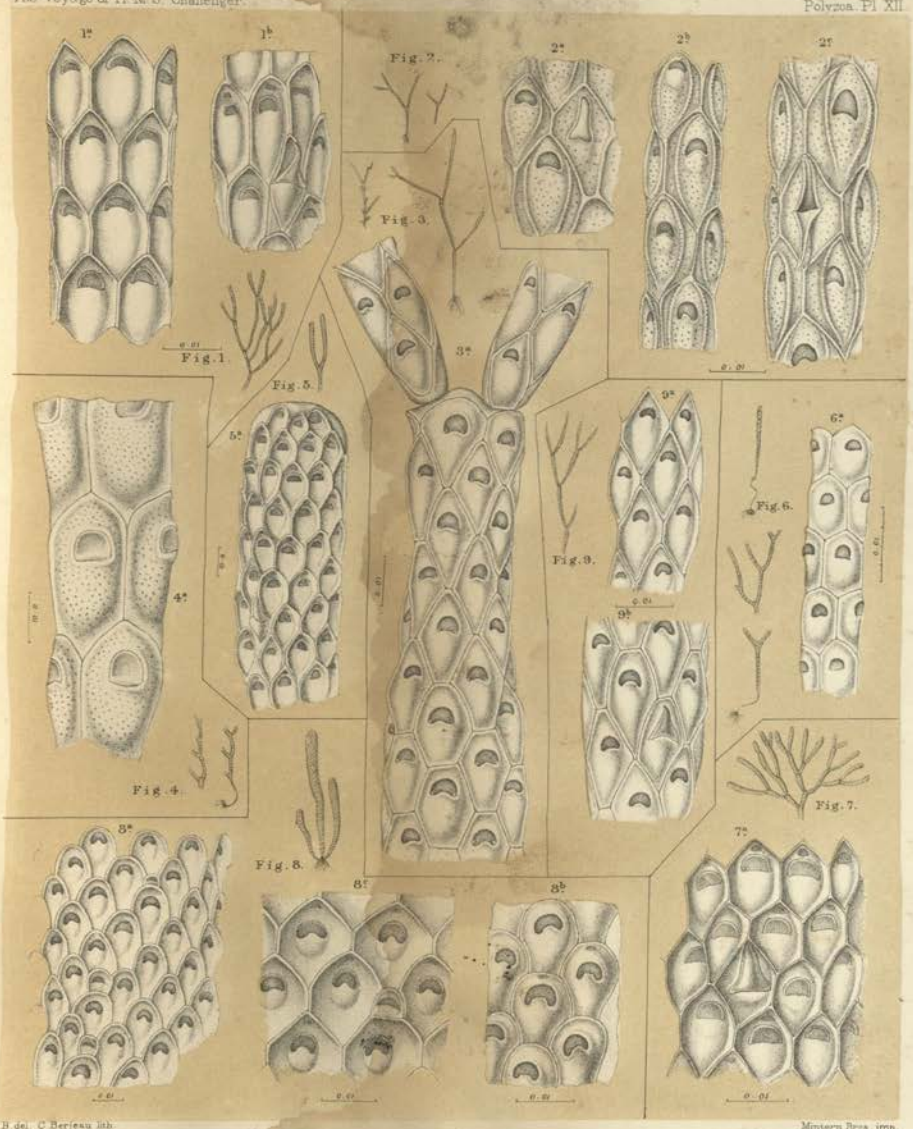
„ 2.—*Salicornaria dubia,** 91
2*a*, 2*b*, 2*c*, magnified.

„ 3, 9.—*Salicornaria variabilis*, ... 89
3*a*, 9*a*, 9*b*, magnified.

„ 4, 6.—*Salicornaria magnifica*, ... 93
4*a*, 6*a*, magnified.

„ 8.—*Salicornaria clavata*, ... 88
8*a*, magnified; 8*b*, 8*c*, more highly magnified.

[1] The species thus marked (*) have been re-named since the plate was printed off.



G.B. del. C. Berjeau lith. Mintern Bros. imp.

1. SALICORNARIA MALVINENSIS. 2. S. TENUIROSTRIS. 3 & 9. S. VARIABILIS.
4 & 6. S. MAGNIFICA. 5 & 7. S. MEGASTOMA. 8. S. CLAVATA.

PLATE XIII.

PLATE XIII.

BIFAXARIA.—ICHTHYARIA.

PAGE

Figure 1.—*Bifaxaria submucronata*, ... 80
1*a*, magnified.

„ 2.—*Bifaxaria lævis*, ... 80
2*a*, magnified; 2*b*, back view.

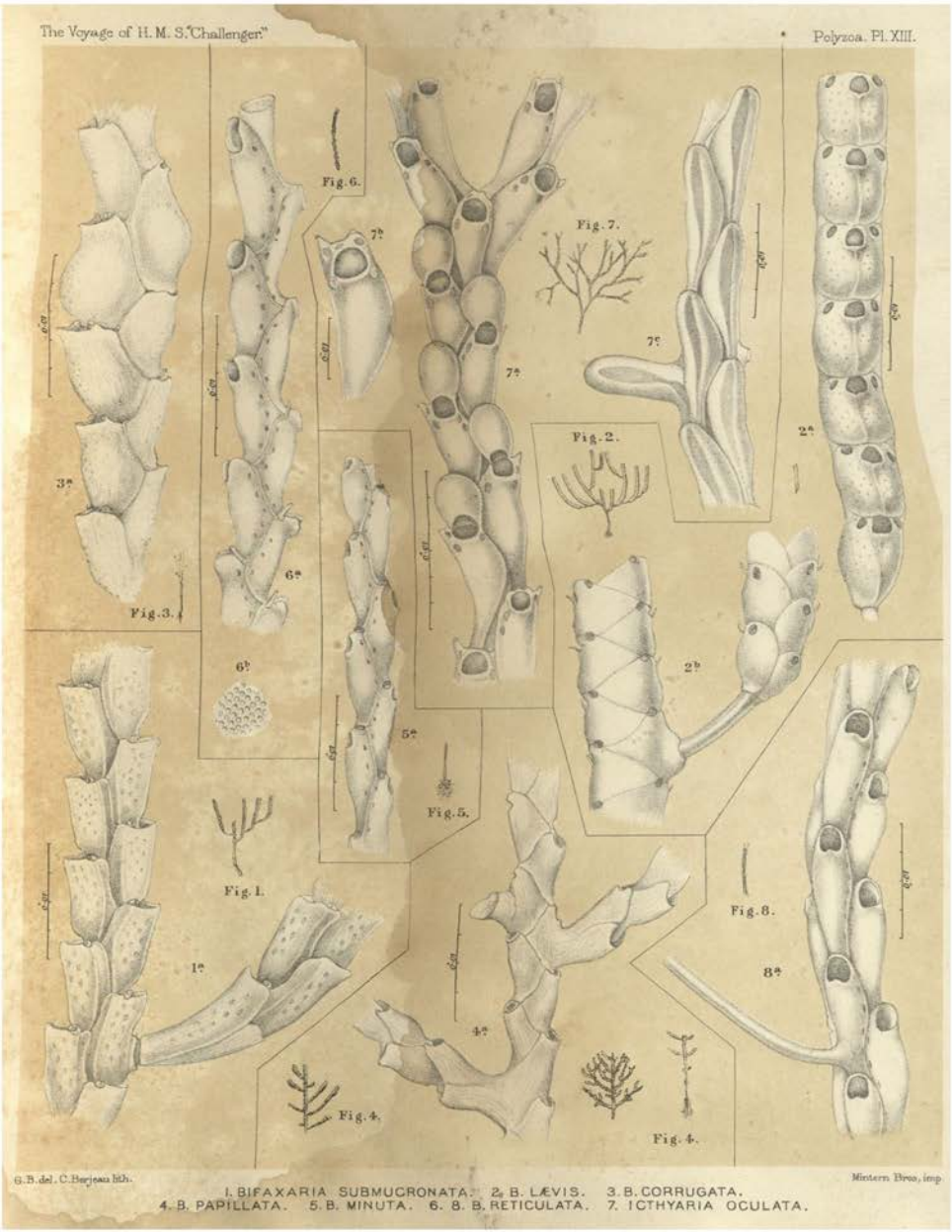
„ 3.—*Bifaxaria corrugata* (Pl. XXIV. fig. 6), ... 80
3*a*, magnified.

„ 4.—*Bifaxaria papillata* (Pl. XXIV. fig. 4), ... 81
4*a*, magnified.

„ 5.—*Bifaxaria minuta*, ... 81
5*a*, magnified.

„ 6, 8.—*Bifaxaria reticulata*, ... 82
6*a*, 8*a*, magnified; 6*b*, portion of zoœcial wall, more highly magnified.

„ 7.—*Ichthyaria oculata*, ... 46
7*a*, magnified; 7*b*, a single zoœcium, more highly magnified;
7*c*, back view.



G.B. del. C. Berjeau lith. Mintern Bros., imp.

1. BIFAXARIA SUBMUCRONATA. 2. B. LÆVIS. 3. B. CORRUGATA.
4. B. PAPILLATA. 5. B. MINUTA. 6. 8. B. RETICULATA. 7. ICTHYARIA OCULATA.

PLATE XIV.

PLATE XIV.

MELICERITA.—BIFLUSTRA.—MEMBRANIPORA.—FOVEOLARIA.—CUPULARIA, &c.

PAGE

Figure 1.—*Melicerita atlantica*, ... 96
1*a*, magnified.

„ 2.—*Biflustra savartii*, ... 67
2*a*, magnified.

„ 3.—*Membranipora crassimarginata*,[1] 63
3*a*, section showing interzoercial pores, "Rosettenplatten."

„ 4.—*Foveolaria tubigera*, ... 68
4*a*, magnified; 4*b*, avicularium; 4*c*, trumpet-shaped process.

„ 5.—*Cupularia monotrema*, ... 207
5*a*, magnified; 5*b*, back view.

„ 6.—*Cupularia guineensis*, ... 206
6*a*, magnified; 6*b*, back view.

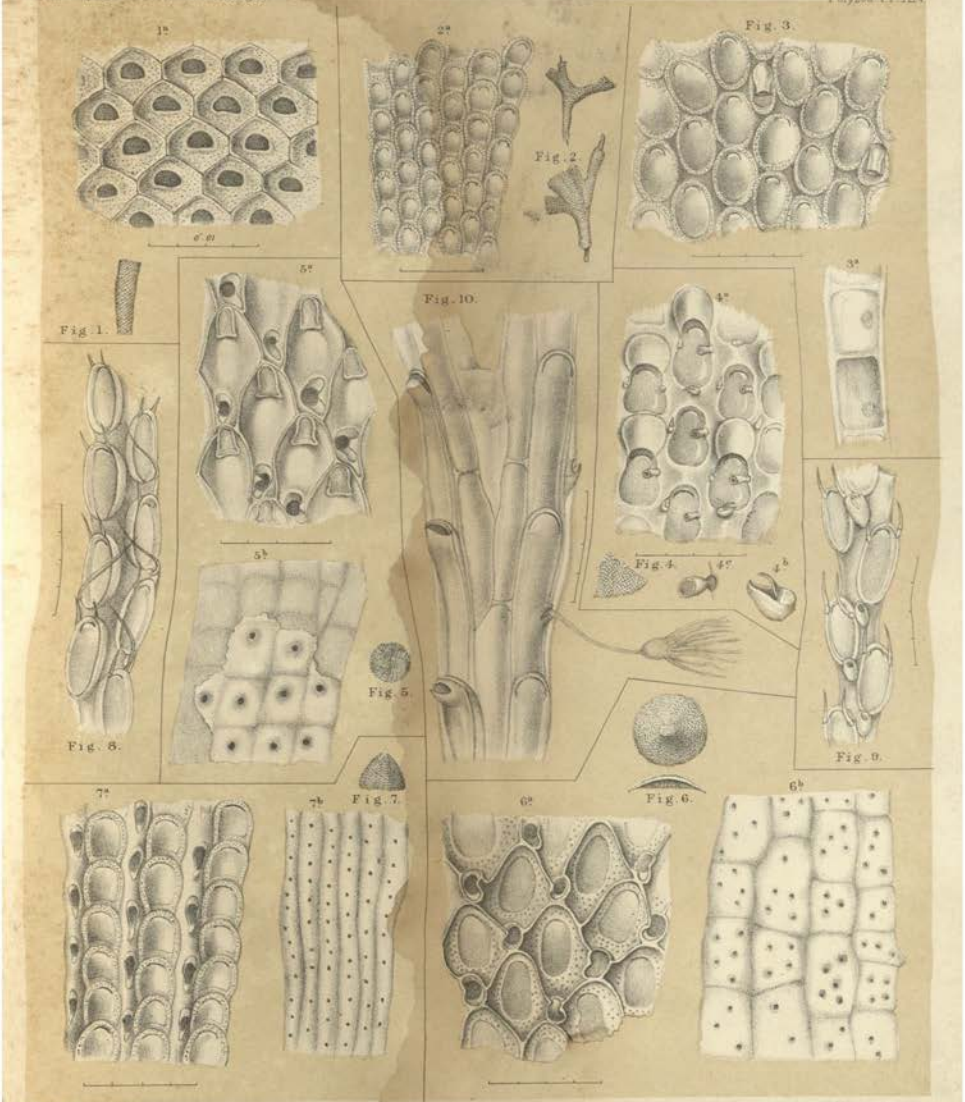
„ 7.—*Lunularia capulus*, ... 208
7*a*, magnified; 7*b*, back view.

„ 8.—*Canda simplex*, ... 26

„ 9.—*Menipea marionensis* (Pl. IV. fig. 3), ... 21

„ 10.—*Farciminaria hexagona*, showing the two series of uninhabited zoœcia (Pl. XXXI. fig. 3), ... 51

[1] *B* at foot of plate should be *M*.



O.B. del. C.Berjeau lith. Mintern Bros. imp.

1. MELICERITA ATLANTICA. 2. BIFLUSTRA SAVARTII. 3. B. CRASSIMARGINATA.
4. FOVEOLARIA TUBIGERA. 5. CUPULARIA MONOTREMA. 6. C. GUINIENSIS.
7. LUNULARIA CAPULUS. 8. CANDA SIMPLEX. 9. MENIPEA MARIONENSIS.
10. FARCIMINARIA HEXAGONA.

PLATE XV.

PLATE XV.[1]

AMPHIBLESTRUM.—SIPHONICYTARA.—MEMBRANIPORA.—FOVEOLARIA.—MICROPORA.

PAGE

Figure 1.—*Amphiblestrum cristatum,** 65
1*a*, 1*b*, 1*c*, cells with oœcia showing the various avicularia; 1*d*, sterile zoœcium.

„ 2.—*Siphonicytara serrulata*, ... 101
2*a*, magnified; 2*b*, back view, with radical tubes.

„ 3.—*Amphiblestrum imbricatum,** 65
3*a*, magnified; 3*b*, avicularium.

„ 4.—*Membranipora albida*, ... 63
4*a*, magnified.

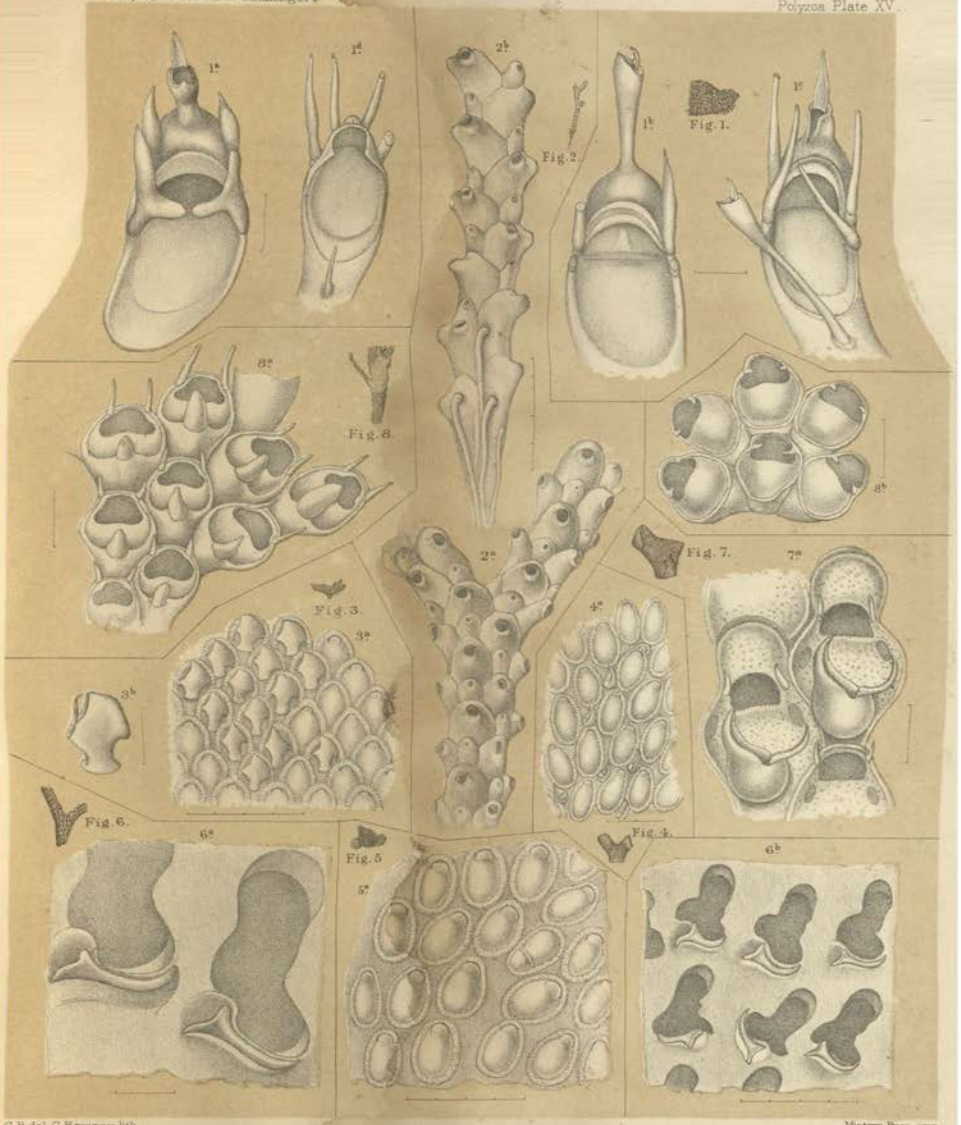
„ 5.—*Membranipora crassimarginata*, var. *incrustans,** . . . 63
5*a*, magnified.

„ 6.—*Foveolaria falcifera*, ... 69
6*a*, 6*b*, magnified.

„ 7.—*Micropora uncifera*, ... 71
7*a*, magnified.

„ 8.—*Amphiblestrum umbonatum,** 66
8*a*, 8*b*, magnified.

[1] The species thus marked (*) have been re-named since the plate was printed off.



G.B. del. C. Berjeau lith.

Mintern Bros. imp.

1. MEMBRANIPORA CRISTATA. 2. SIPHONICYTARA SERRULATA. 3. MEMBRANIPORA IMBRICATA.
4. M. ALBIDA. 5. BIFLUSTRA CRASSIMARGINATA. 6. FOVEOLARIA FALCIFERA.
7. MICROPORA UNCIFERA. 8. MEMBRANIPORA UMBONATA.

PLATE XVI.

PLATE XVI.

FLUSTRA.—DIACHORIS.—CARBASEA.

PAGE

Figure 1.—*Flustra biseriata*, ... 54
1*a*, magnified.

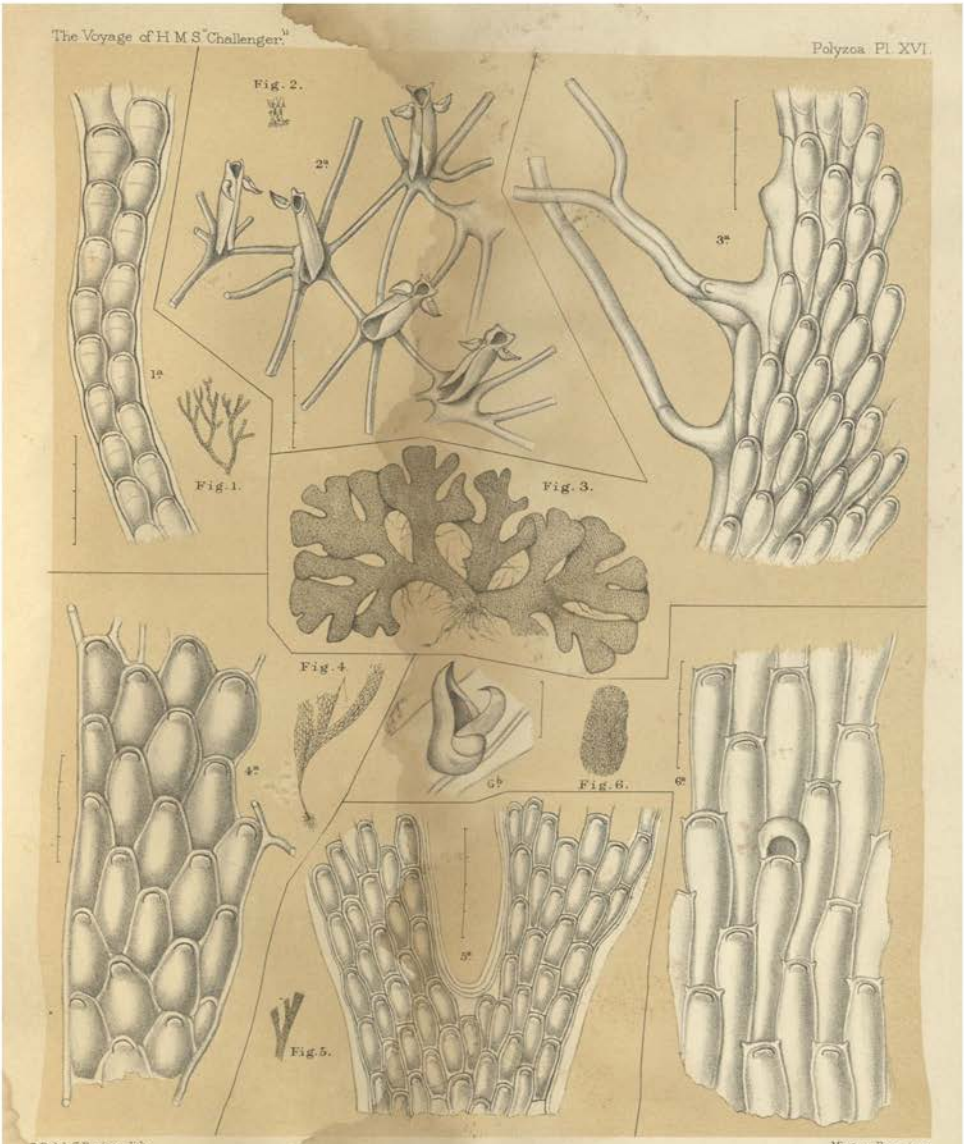
„ 2.—*Diachoris magellanica*, var. *distans*, ... 59
2*a*, magnified.

„ 3.—*Carbasea ovoidea*, ... 55
3*a*, magnified.

„ 4.—*Carbasea pedunculata*, ... 56
4*a*, magnified.

„ 5.—*Carbasea elegans*, ... 56
5*a*, magnified.

„ 6.—*Flustra crassa*, ... 53
6*a*, magnified; 6*b*, avicularium.



G.B del. C Berjeau lith.

Mintern Bros. imp.

1. FLUSTRA BISERIATA. 2. DIACHORIS MAGELLANICA, *VAR.* DISTANS.
3. CARBASEA OVOIDEA. 4. C. PEDUNCULATA. 5. C. ELEGANS. 6. FLUSTRA CRASSA.

PLATE XVII.

PLATE XVII.[1]

SCHIZOPORELLA.—SMITTIA.—LEPRALIA.—CRIBRILINA.—MUCRONELLA.

PAGE

Figure 1.—*Schizoporella nivea*, ... 163
1*a*, magnified.

„ 2.—*Schizoporella longispinata*, ... 163
2*a*, magnified; 2*b*, single zoœcium, more highly magnified; 2*c*, oœcium.

„ 3.—*Smittia smittiana*, ... 151
3*a*, magnified; 3*b*, oœcium.

„ 4.—*Lepralia celleporoides*, ... 142
4*a*, magnified; 4*b*, more highly magnified.

„ 5.—*Lepralia japonica*, ... 143
5*a*, magnified.

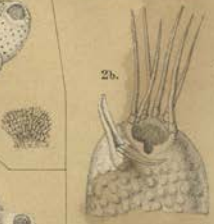
„ 6.—*Cribrilina philomela*, ... 132
6*a*, magnified; 6*b*, oœcium.

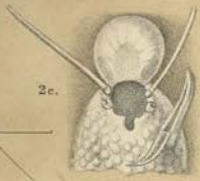
„ 7.—*Lepralia tuberosa*, ... 143
7*a*, magnified; 7*b*, with oœcium; 7*c*, single zoœcium, more highly magnified; 7*d*, back view.

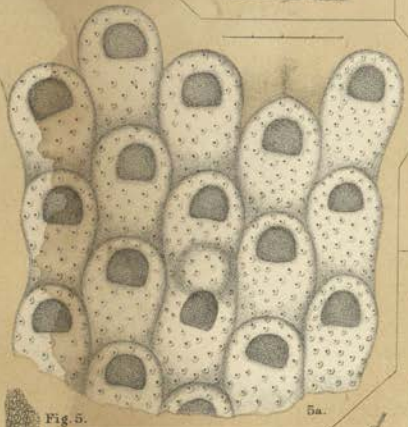
„ 8.—*Mucronella quadrata*[2] (Pl. XVIII. fig. 5), ... 156
8*a*, magnified.

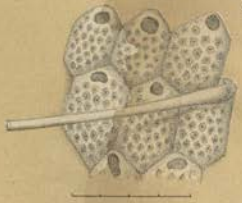
[1] When the plate was prepared all these forms were included under the generic term *Hemeschara*, which has since been discarded in accordance with more modern views.

[2] Altogether misnamed on the plate.









G.B.del. C.Berjeau lith.

Mintern Bros, imp.

1. HEMESCHARA NIVEA. 2. H. LONGISPINATA. 3. H. SMITTIANA. 4. H. CELLEPOROIDES.
5. H. JAPONICA. 6. H. PHILOMELA. 7. H. TUBEROSA. 8. H. MONOCEROS.

PLATE XVIII.

PLATE XVIII.[1]

SMITTIA.—MUCRONELLA.—LEPRALIA.

PAGE

Figure 1.—*Smittia marsupialis*, ... 151
1*a*, magnified; 1*b*, œcium.

„ 2.—*Mucronella delicatula*, ... 156
2*a*, magnified; 2*b*, single zoœcium, more highly magnified.

„ 3.—*Mucronella magnifica*, ... 158
3*a*, magnified; 3*b*, single zoœcium, more highly magnified.

„ 4.—*Lepralia dorsiporosa*, ... 143
4*a*, magnified; 4*b*, back view.

„ 5.—*Mucronella quadrata* (Pl. XVII. fig. 8), ... 156
5*a*, magnified; 5*b*, single zoœcium, more highly magnified.

„ 6.—*Smittia marionensis*, ... 152
6*a*, magnified; 6*b*, single zoœcium, more highly magnified.

„ 7.—*Smittia transversa*, ... 152
7*a*, magnified; 7*b*, single zoœcium, more highly magnified.

[1] *Vide* note to Pl. XVII.

Fig. 1.

Fig. 2.

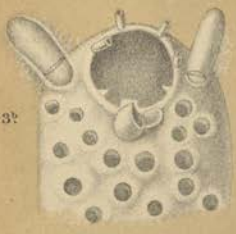


Fig. 3.

Fig. 5.

Fig. 4.

Fig. 6.

Fig. 7.

G.B. del. C. Bayeau lith.

Mintern Bros., imp.

1. HEMESCHARA MARSUPIALIS. 2. H. DELICATULA. 3. H. MAGNIFICA.
4. H. DORSIPOROSA. 5. H. QUADRATA. 6. H. MARIONENSIS. 7. H. TRANSVERSA.

PLATE XIX.

PLATE XIX.[1]

SCHIZOPORELLA.—MUCRONELLA.—CRIBRILINA.—SMITTIA.

PAGE

Figure 1.—*Schizoporella auriculata*, var. *alba*,[2] 164
1*a*, magnified ; 1*b*, single zoœcium, more highly magnified.

„ 2.—*Mucronella rostrigera*, ... 156
2*a*, magnified ; 2*b*, single zoœcium, more highly magnified.

„ 3.—*Schizoporella jacksoniensis*, ... 164
3*a*, magnified ; 3*b*, more highly magnified.

„ 4.—*Cribrilina labiosa*, ... 133
4*a*, magnified ; 4*b*, single zoœcium, more highly magnified.

„ 5.—*Mucronella bisinuata*, ... 157
5*a*, magnified ; 5*b*, single zoœcium, more highly magnified.

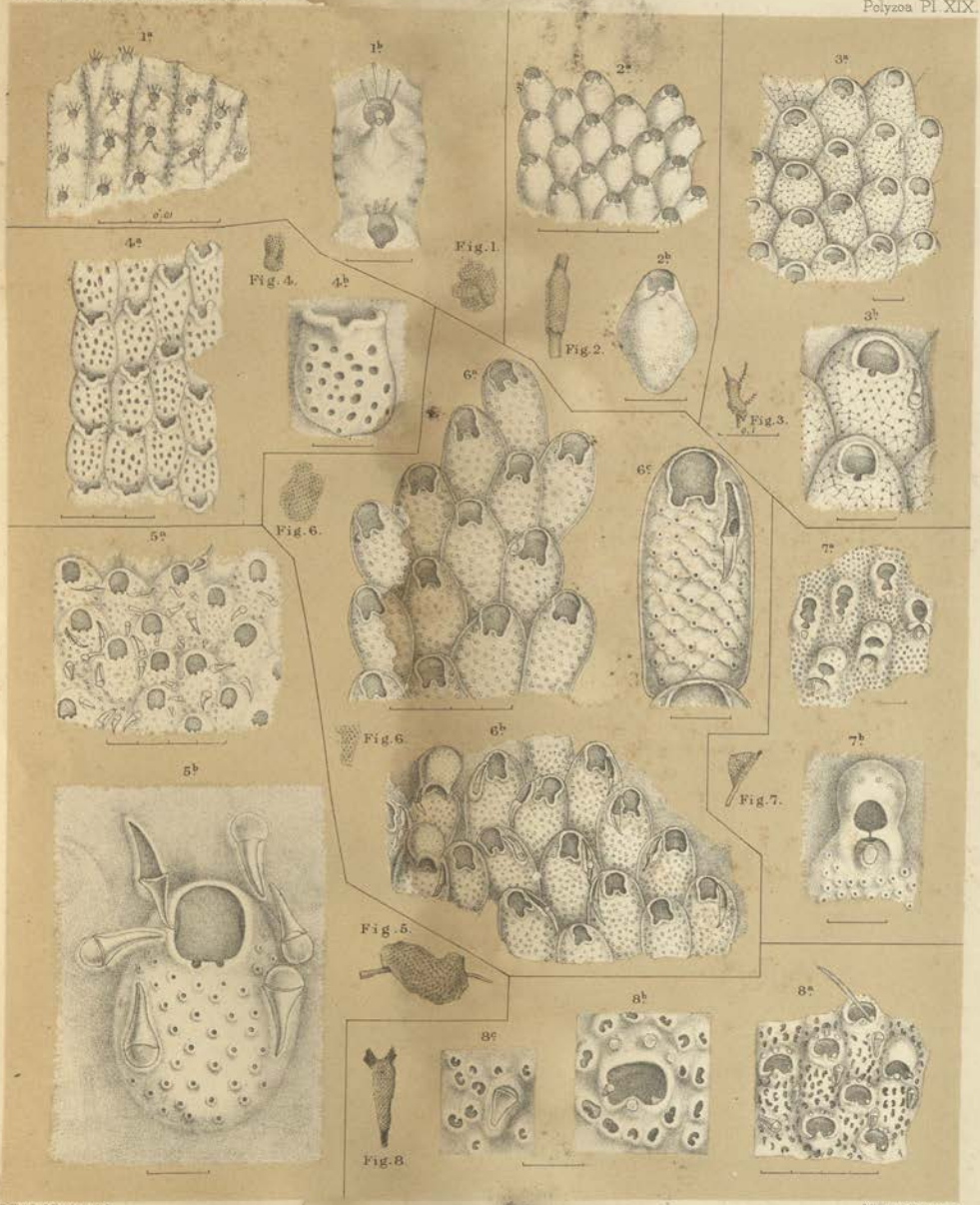
„ 6.—*Mucronella castanea*, ... 157
6*a*, magnified ; 6*b*, 6*c*, with avicularia.

„ 7.—*Smittia jacobensis*, ... 153
7*a*, magnified ; 7*b*, oœcium.

„ 8.—*Cribrilina monoceros*, ... 133
8*a*, magnified ; 8*b*, orifice ; 8*c*, avicularium, more highly magnified.

[1] *Vide* note to Pl. XVII.

[2] This name has been changed, but with some doubt as to the correctness of so doing.



C.Hidel. C.Berjeau lith.

Mintern Bros. imp.

1. HEMESCHARA ROSTRIFERA. 2. H. MUCRONATA. 3. H. JACKSONIENSIS. 4. H. CRIBRARIA.
5. H. BISINUATA. 6. H. CASTANEA. 7. H. JACOBENSIS. 8. H. MONOCEROS.

PLATE XX.

PLATE XX.[1]

SMITTIA.—ADEONELLA.—PORELLA.—ESCHARA, &c

PAGE

Figure 1.—*Smittia tenuis*, ... 150
1*a*, magnified; 1*b*, single zoœcium, more highly magnified.

„ 2.—*Adeonella regularis* (woodcut 53), ... 186
2*a*, magnified; 2*b*, single zoœcium, more highly magnified.

„ 3.—*Porella lævis*, var. *subcompressa*, ... 149
3*a*, magnified; 3*b*, single zoœcium, more highly magnified.

„ 4.—*Adeonella distoma*, var. *imperforata*, ... 188
4*a*, magnified; 4*b*, single zoœcium, more highly magnified.

„ 5.—*Mucronella pyriformis*, ... 155
5*a*, 5*b*, magnified.

„ 6.—*Eschara elegantula*, ... 141
6*a*, 6*b*, magnified.

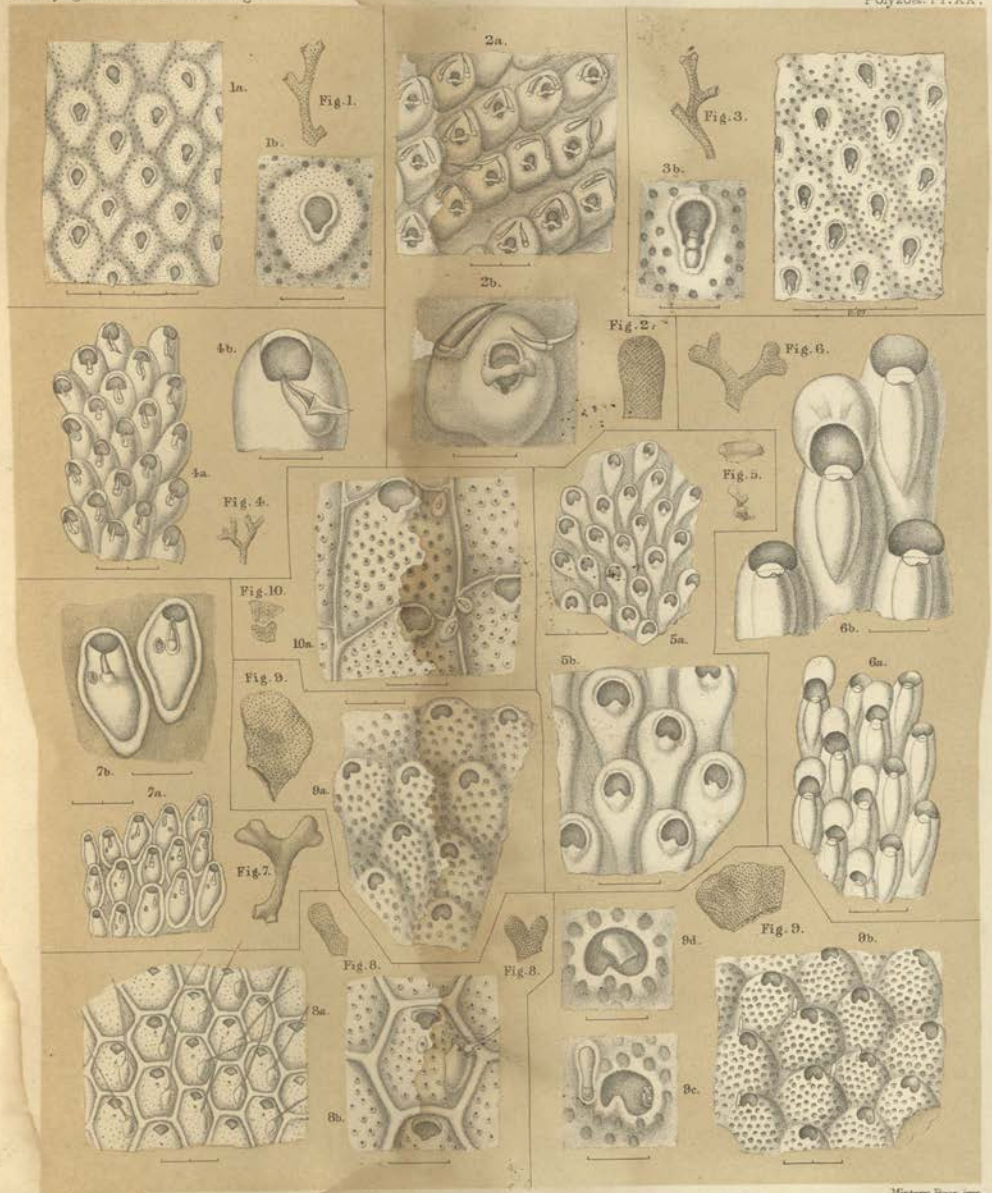
„ 7.—*Adeonella atlantica* (Pl. XXI. fig. 1) (woodcut 52), . . . 186
7*a*, magnified; 7*b*, zoœcia, more highly magnified.

„ 8.—*Flustramorpha marginata*, ... 135
8*a*, magnified; 8*b*, more highly magnified.

„ 9.—*Mucronella contorta*, ... 155
9*a*, magnified; 9*b*, with avicularia; 9*c*, 9*d*, orifice and avicularia, more highly magnified.

„ 10.—*Schizoporella tenuis*, ... 165
10*a*, magnified.

[1] The generic names given above have been substituted for that of *Eschara*, which, as seen in the text, I have now employed in a much more restricted sense.



G.B. del. C. Berjeau lith. Mintern Bros., imp.

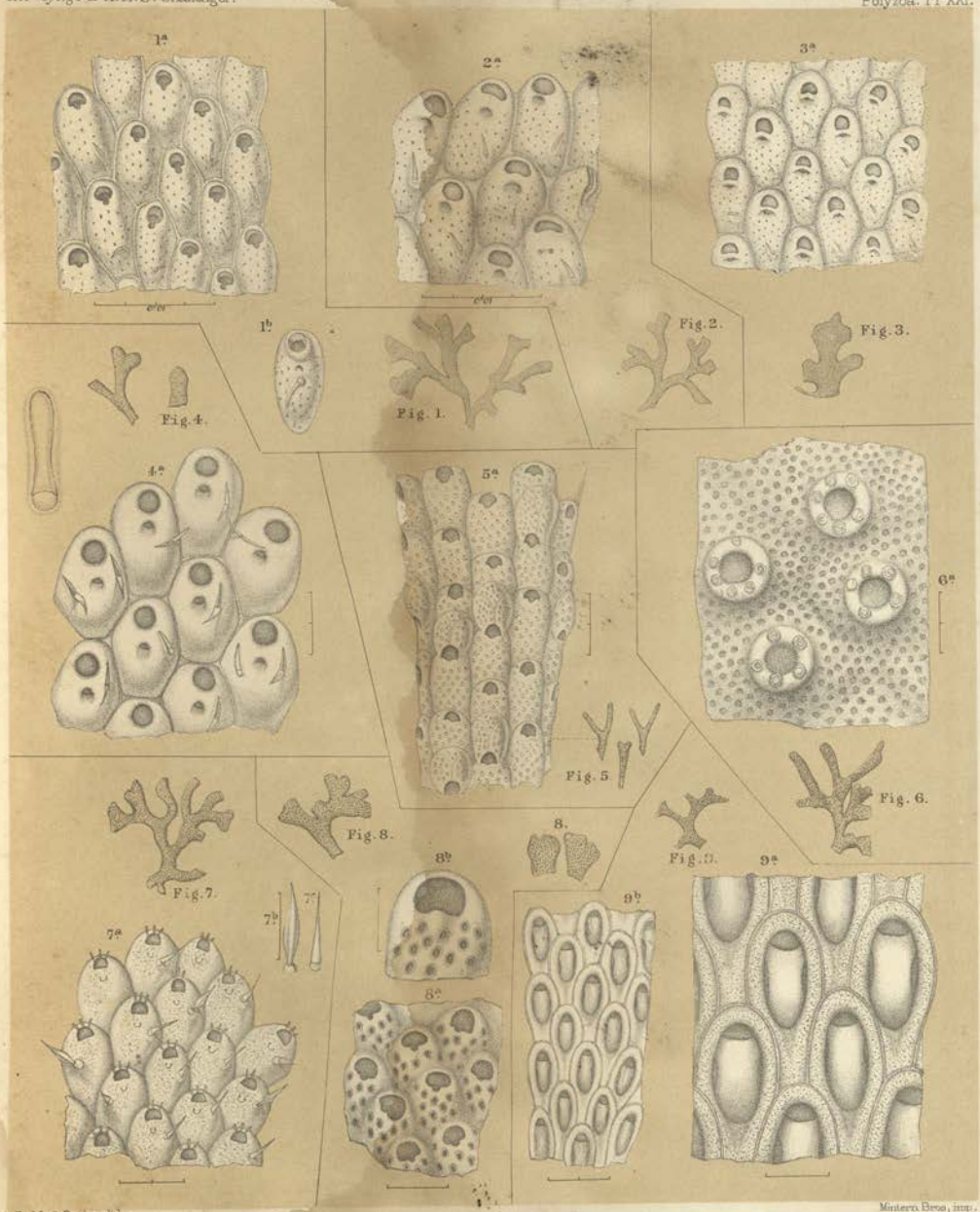
I. ESCHARA TENUIS. 2. E. REGULARIS. 3. E. DOLICHOSTOMA. 4. E SULCATA. 5. E. PYRIFORMIS.
6. E. ELEGANTULA. 7. E. SUBSULCATA. 8. E. FLAGELLIFERA. 9. E. CONTORTA. 10. HEMESCHARA TENUIS.

PLATE XXI.

PLATE XXI.[1]

ADEONELLA.—SCHIZOPORELLA.—ESCHARA.—FLUSTRAMORPHA, &c.

		PAGE
Figure	1.—*Adeonella atlantica* (Pl. XX. fig. 7), ... 1*b*, single zoœcium, magnified.	186
,, 1*a*, 2*a*,	3.—*Adeonella polymorpha*, ... 1*a*, 2*a*, 3*a*, magnified.	183
,,	2.—*Adeonella intricaria*, ...	185
,,	4.—*Adeonella platalea*, ... 4*a*, magnified.	184
,,	5.—*Schizoporella furcata*, ... 5*a*, magnified.	163
,,	6.—*Eschara gracilis*, ... 6*a*, magnified.	141
,,	7.—*Flustramorpha hastigera*, ... 7*a*, magnified; 7*b*, 7*c*, vibracula.	136
,,	8.—*Escharoides occlusa*, ... 8*a*, magnified; 8*b*, single zoœcium.	150
,,	9.—*Caleschara denticulata*, var. *tenuis*, ... 9*b*, magnified; 9*a*, more highly magnified.	70



G.B. del. C. Berjeau lith. Mintern Bros., imp.

1. 2. 3. ESCHARA POLYMORPHA. 4. E. TUMIDULA. 5. E. FURCATA.
6. E. CORONATA. 7. E. HASTIGERA. 8. E. OCCLUSA. 9. VINCULARIA TENUIS.

PLATE XXII.[1]

SMITTIA.—MUCRONELLA.—LEPRALIA.—CRIBRILINA.—SCHIZOPORELLA.—CHORIZOPORA.

PAGE

Figure 1.—*Smittia oratavensis*, ... 153

„ 2.—*Mucronella canalifera*, ... 159

„ 3.—*Mucronella tricuspis*, ... 159
3*a*, avicularium.

„ 4.—*Lepralia hyalina*, var. *bougainvillei*, ... 148

„ 5.—*Mucronella simplicissima*, ... 160

„ 6.—*Smittia stigmatophora*, ... 154

„ 7.—*Cribrilina philomela*, var. *adnata*, ... 132

„ 8.—*Schizoporella elegans*, ... 165
8*a*, operculum.

„ 9.—*Lepralia feegeensis*, ... 144
9*a*, 9*b*, orifice and avicularium; more highly magnified.

„ 10.—*Cribrilina latimarginata*, ... 131

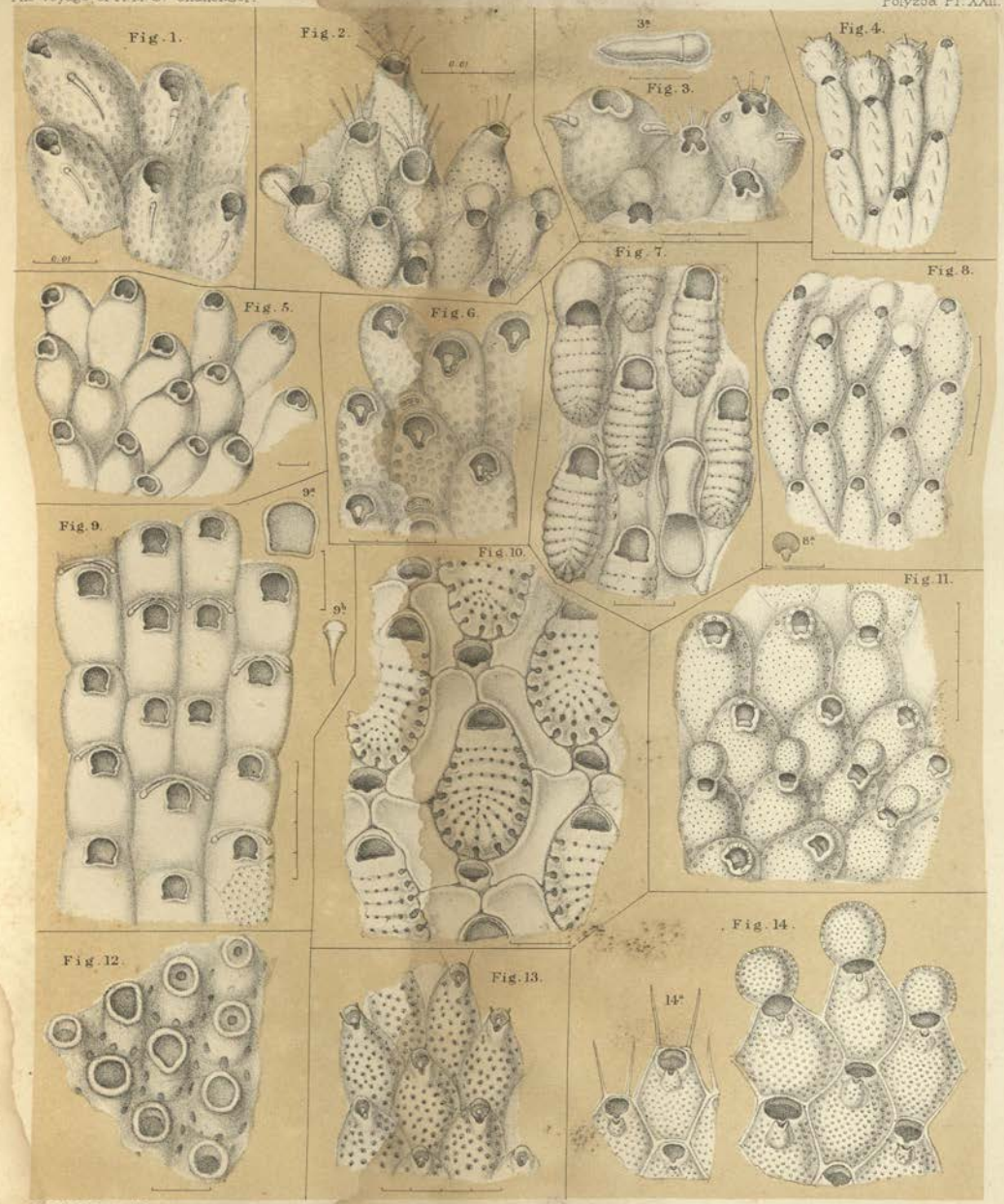
„ 11.—*Mucronella ventricosa*, var. *multispinata*, ... 160

„ 12.—*Chorizopora honolulensis*, ... 148

„ 13.—*Smittia graciosa*, ... 154

„ 14.—*Schizoporella marsupifera*, ... 165
14*a*, orifice, more highly magnified.

[1] *Vide* note to Pl. XX. For similar reasons the term *Lepralia* has been replaced in the above list.



G.B. del. C. Berjeau lith. Mintern Bros. imp.

1. LEPRALIA OPHIDIANA. 2. L. CANALIFERA. 3. L. COCCINEA. 4. L. HYALINA *VAR.* BOUGAINVILLEI. 5. L. SIMPLICISSIMA. 6. L. STIGMATOPHORA. 7. HEMESCHARA PHILOMELA *(LEPRALIOID FORM.)* 8. L. ELEGANS. 9. L. FEEGEENSIS. 10. L. LATIMARGINATA. 11. L. VENTRICOSA *VAR.* MULTISPINATA. 12. L. HONOLULENSIS. 13. L. GRACIOSA. 14. L. MARSUPIFERA.

PLATE XXIII.

PLATE XIII.[1]

Vincularia.—Foveolaria.—Myriozoum, &c.

PAGE

Figure 1.—*Vincularia gothica*, ... 72

1*a*, magnified; 1*b*, more highly magnified, showing the gradual formation of the bridge across the orifice; 1*c*, slightly magnified portion of young branch in which the cells are quadriserial; 1*d*, transverse section of same.

,, 2.—*Steganoporella magnilabris*,* 75

2*a*, magnified.

,, 3.—*Amphiblestrum capense*,* 67

3*a*, magnified.

,, 4.—*Foveolaria orbicularis*, ... 68

4*a*, magnified; 4*b*, orifice; 4*c*, avicularium, more highly magnified.

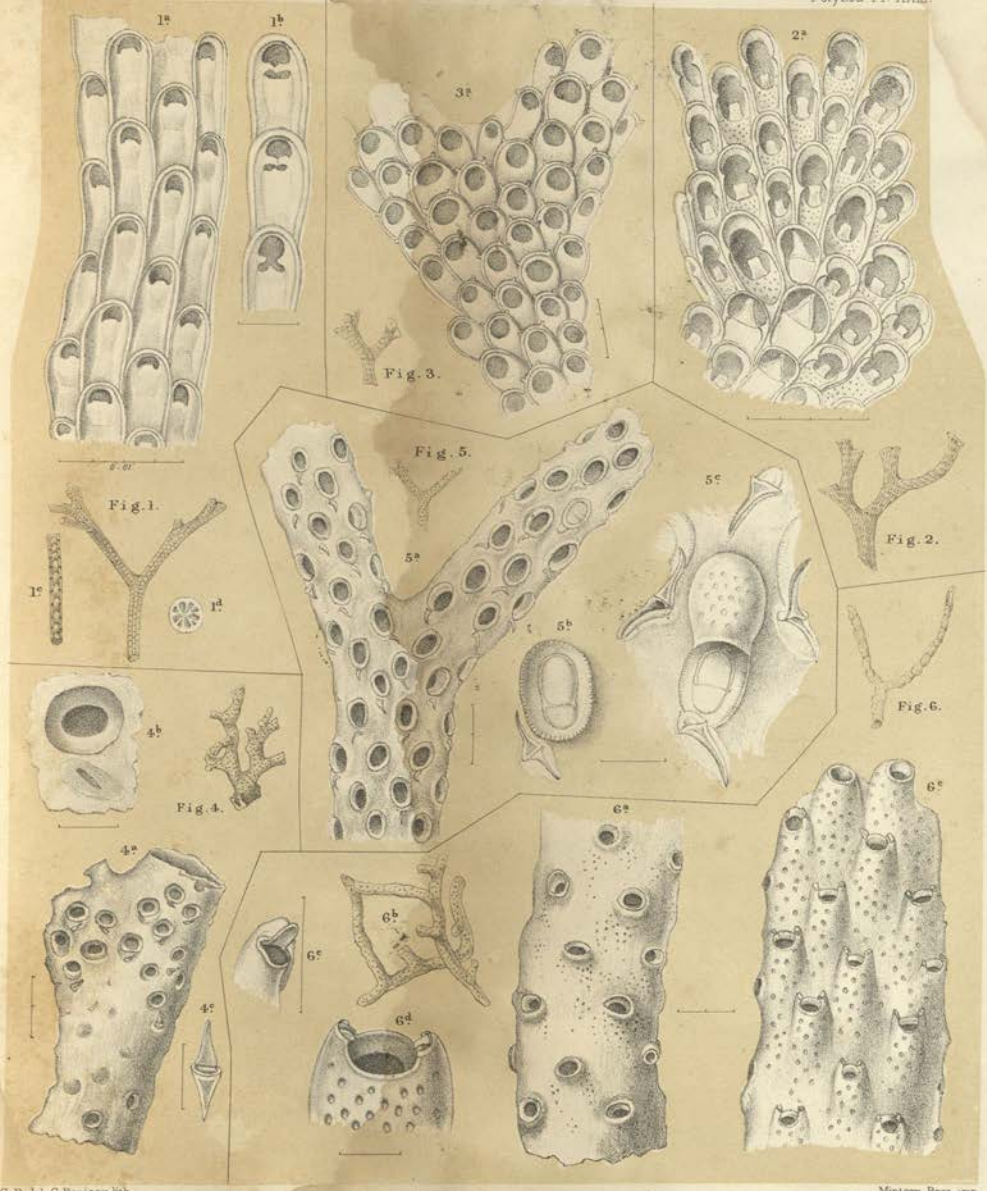
,, 5.—*Foveolaria elliptica*, ... 68

5*a*, magnified; 5*b*, 5*c*, oœcium and avicularia.

,, 6.—*Myriozoum marionense*, ... 171

6*a*, magnified; 6*b*, ramose variety; 6*c*, younger portion of the zoarium; 6*d*, single zoœcium; 6*e*, oral avicularium, more highly magnified.

[1] The species thus marked (*) have been re-named since the plate was printed off.



G.B. del. C.Berjeau lith.

Mintern Bros. imp.

1. VINCULARIA GOTHICA. 2. V. MAGNILABRIS. 3. V. CAPENSIS.
4. FOVEOLARIA ORBICULARIS. 5. F. ELLIPTICA. 6. MYRIOZOUM MARIONENSE.

PLATE XXIV.

PLATE XXIV.[1]

TURRITIGERA.—RETEPORELLA.—BIFAXARIA.—HASWELLIA, &c.

PAGE

Figure 1A.—*Turritigera stellata*, ... 130
1B, orifice with columnar processes; 1C, 1E, avicularia; 1D, dorsal opening with young Crinoid issuing from it; 1F, orifice with avicularian process; 1G, back view.

„ 2A.—*Reteporella myriozoides*, ... 127
2B, magnified; 2C, orifice and avicularium.

„ 3A.—*Bifaxaria denticulata*, ... 82
3B, magnified; 3C, avicularia.

„ 4A.—*Bifaxaria papillata* (Pl. XIII. fig. 4), ... 81
4B, 4C, magnified; 4D, showing papilliform avicularium.

„ 5A.—*Bifaxaria abyssicola*, ... 82
5B, magnified; 5C, 5D, lateral aspect; 5E, transverse section of the zoarium, showing the position of the zoœcia and avicularia.

„ 6.—*Bifaxaria corrugata*, showing papilliform avicularia (Pl. XIII. fig. 3), ... 80

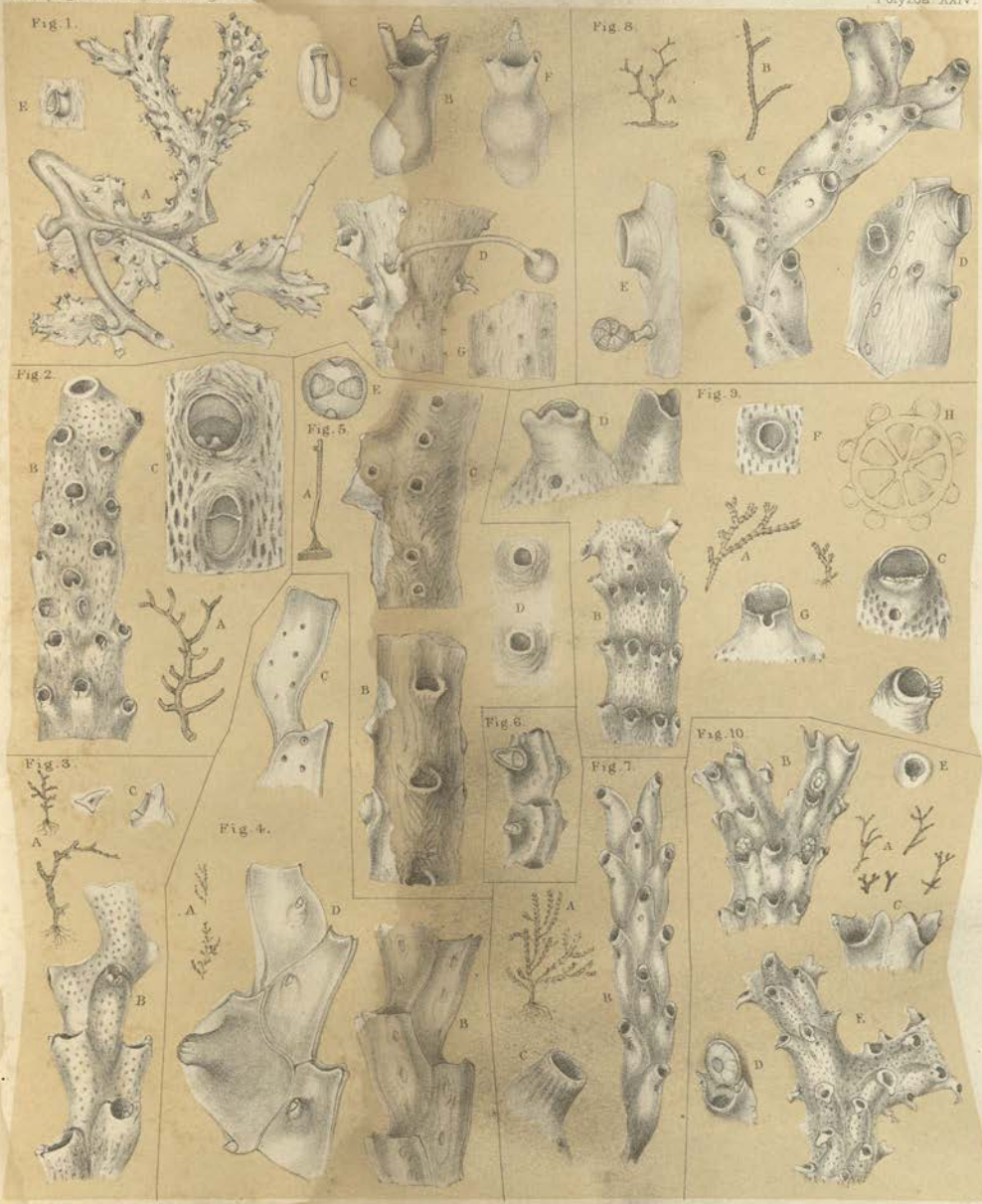
„ 7A.—*Tubucellaria opuntioides* * (Pl. XXXVI. fig. 19), ... 100
7B, magnified; 7C, orifice, more highly magnified.

„ 8A, 8B.—*Tessaradoma boreale*, ... 174
8C, magnified; 8D, more highly magnified; 8E, showing median pore with *Rotalina* attached.

„ 9A.—*Haswellia australiensis*, ... 172
9B, magnified; 9C, 9D, 9F, 9G, orifices at various stages; 9H, transverse section.

„ 10A.—*Haswellia auriculata*,* 173
10B, 10C, older part of zoarium and orifices; 10D, oœcium; 10E, primary orifice with emarginate lower border.

[1] The species thus marked (*) have been re-named since the plate was printed off.



G.B. del. C. Berjeau lith. Mintern Bros. imp.

1. TURRITIGERA STELLATA. 2. RETEPORA MYRIOZOIDES. 3. BIFAXARIA DENTICULATA.
4. B. PAPILLATA. 5. B. ABYSSICOLA. 6. B. CORRUGATA. 7. TUBUCELLARIA CEREOIDES (var)
8. TESSARADOMA BOREALE. 9. T. VERTICILLATUM. 10. T. AURICULATUM.

PLATE XXV.

PLATE XXV.

MYRIOZOUM.—GEMELLIPORA.—RETEPORELLA.—RETEPORA.

PAGE

Figure 1.—*Myriozoum simplex*, ... 170
1*a*, magnified; 1*c*, orifice in the younger part; 1*d*, orifice in older part.

„ 2.—*Myriozoum honolulense*, ... 170
2*a*, magnified; 2*b*, transverse section; 2*c*, lateral wall of zoœcium.

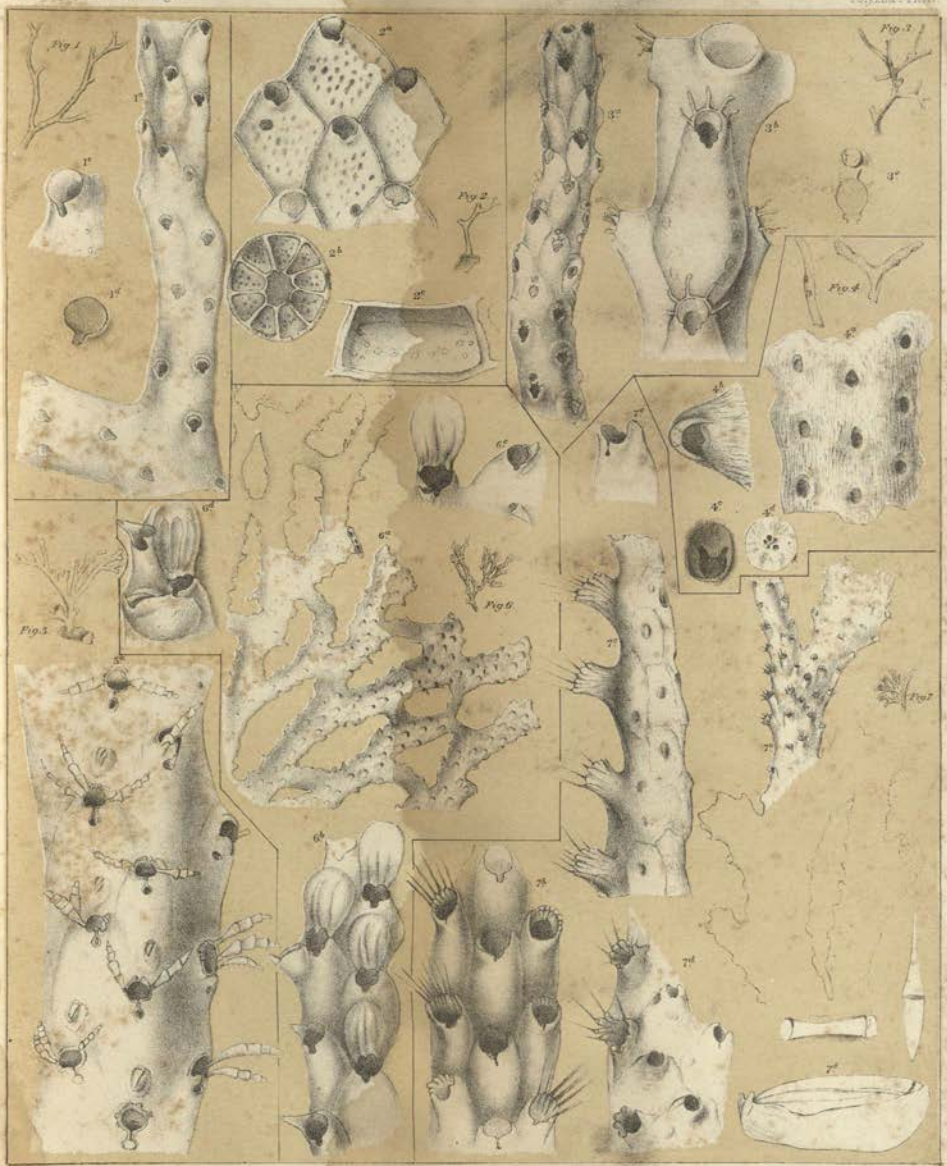
„ 3.—*Gemellipora glabra*, ... 176
3*a*, magnified; 3*b*, more highly magnified; 3*c*, orifice and avicularium.

„ 4.—*Myriozoum immersum*, ... 170
4*a*, magnified; 4*b*, orifice; 4*c*, orifice viewed from above; 4*d*, transverse section.

„ 5.—*Reteporella flabellata*, ... 126
5*a*, magnified.

„ 6.—*Retepora apiculata*, ... 108
6*a*, magnified; 6*b*, with oœcia; 6*c*, more highly magnified.

„ 7.—*Retepora producta*, ... 108
7*a*, magnified; 7*b*, 7*c*, 7*d*, different views, more highly magnified; 7*e*, primary orifice; 7*f*, avicularium.



G.B. del. G. West Junr lith. Hanhart Imp.

1. TESSARADOMA SIMPLEX. 2. MYRIAZOUM HONOLULENSE. 3. M. GLABRUM.
4. M. IMMERSUM. 5. RETEPORA FLABELLATA. 6. R. APICULATA. 7. R. PRODUCTA.

PLATE XXVI.

PLATE XXVI.

RETEPORA.

PAGE

Figure 1*a*.—*Retepora denticulata*, ... 109
1*b*, more highly magnified; 1*c*, 1*d*, avicularia.

„ 2*a*.—*Retepora contortuplicata*, ... 120
2*b*, more highly magnified.

„ 3*a*.—*Retepora delicatula*, ... 125
3*b*, 3*c*, more highly magnified; 3*d*, mandible of fenestral avicularium.

„ 4*a*.—*Retepora hirsuta*, ... 119
4*b*, more highly magnified; 4*c*, œcium with trifoliate stigma; 4*d*, 4*e*, avicularia; 4*f*, 4*g*, antenniform spines.

„ 5*a*.—*Retepora columnifera*, ... 122
5*b*, zoœcia more highly magnified; 5*c*, columnar avicularium; 5*d*, 5*e*, fenestral avicularium and mandible.

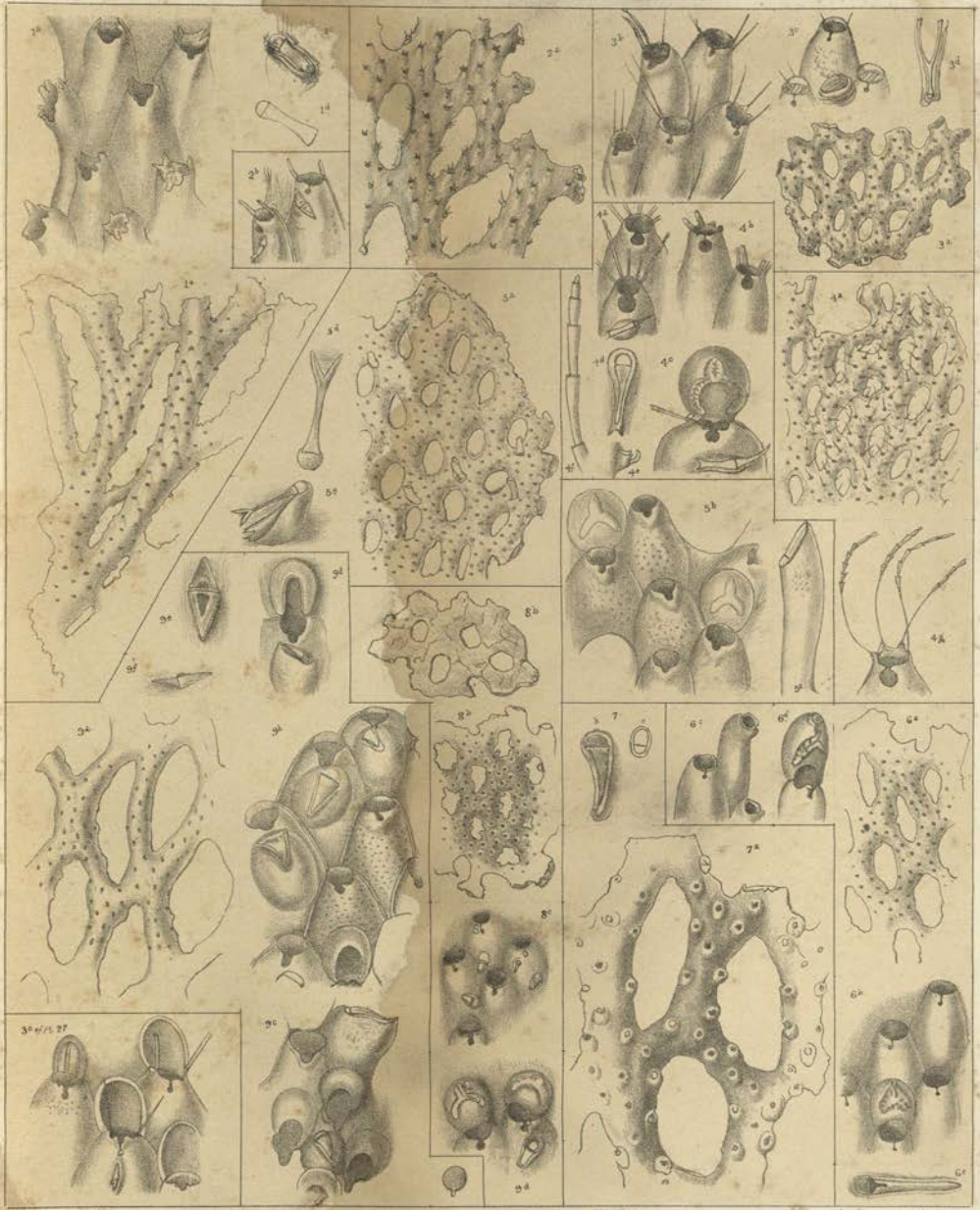
„ 6*a*.—*Retepora mucronata*, ... 120
6*b*, zoœcia more highly magnified; 6*c*, orifices with pyramidal mucro; 6*d*, œcium.

„ 7*a*.—*Retepora gigantea*, ... 114
7*b*, 7*c*, avicularia.

„ 8*b*.—*Retepora cavernosa*, ... 121
8*c*, magnified; 8*d*, œcia.

„ 9*a*.—*Retepora imperati*, ... 110
9*b*, zoœcia, magnified; 9*c*, œcia; 9*d*, 9*e*, 9*f*, avicularia.

„ 10.—*Retepora crassa*, œcia (Pl. XXVII. fig. 3), . . . 115



G.B. del. Purkis & lith. Hanhart imp.

1. RETEPORA DENTICULATA
2. " CONTORTUPLICATA.
3. " DELICATULA.
4. " HIRSUTA.
5. RETEPORA COLUMNIFERA.
6. " MUCRONATA.
7. " GIGANTEA.
8. CAVERNOSA.
9. RETEPORA IMPERATI.

PLATE XXVII.

PLATE XXVII.

Retepora.

PAGE

Figure 1.—*Retepora lata*, ... 115
1*a*, magnified.

„ 2.—*Retepora margaritacea*, ... 125
2*a*, 2*b*, showing the two kinds of avicularia.

„ 3.—*Retepora crassa* (Pl. XXVI. fig. 10), ... 115
3*b*, magnified.

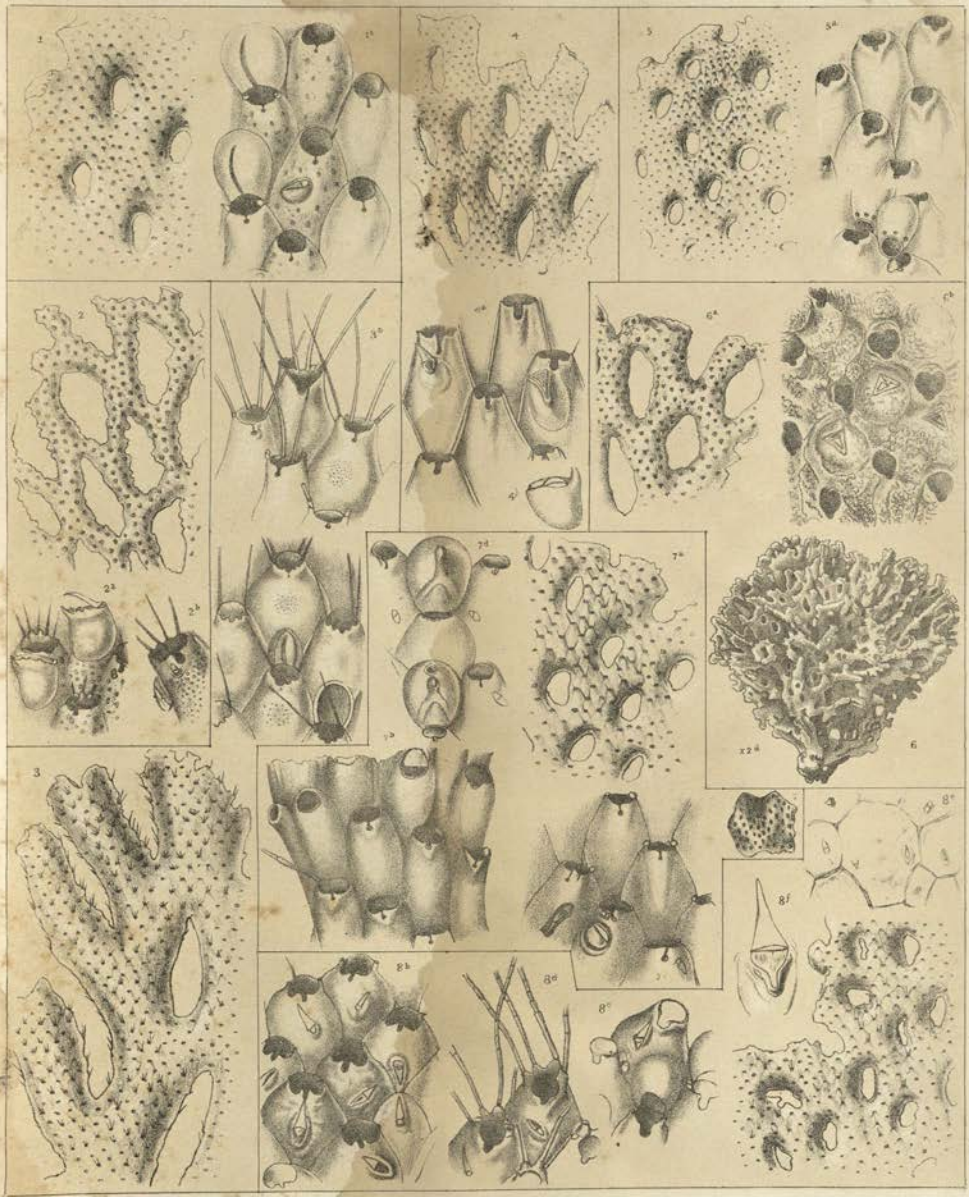
„ 4.—*Retepora jacksoniensis*, ... 125
4*a*, magnified; 4*b*, rostral avicularium.

„ 5.—*Retepora philippinensis*, ... 123
5*a*, magnified; oœcia shown below.

„ 6.—*Retepora tessellata*, var. *cæspitosa*, ... 113
6*a*, magnified; 6*b*, zoœcia, more highly magnified.

„ 7.—*Retepora victoriensis*, ... 117
7*a*, magnified; 7*b*, more highly magnified; 7*c*, various avicularia; 7*d*, oœcia.

„ 8.—*Retepora tessellata*, ... 112
8*b*, magnified; 8*c*, oœcium; 8*d*, oral spines of the younger zoœcia; 8*e*, dorsal surface; 8*f*, rostriform avicularium.



G.B. & P. del. Purkiss lith. Hanhart imp.

1. RETEPORA LATA
2. " MARGARITACEA
3. " CRASSA
4. " JACKSONIENSIS
5. RETEPORA PHILIPPINENSIS
6. " CŒSPITOSA
7. " VICTORIENSIS
8. " TESSELATA

PLATE XXVIII.

PLATE XXVIII.[1]

RETEPORA.—CELLEPORA.—CHLIDONIA.

PAGE

Figure 1.—*Retepora atlantica*,* 116
1*a*, magnified; 1*b*, œcium.

„ 2.—*Retepora tubulata*, ... 121
2*a*, 2*b*, magnified.

„ 3.—*Retepora tessellata*, var. *pubens*, ... 113
3*a*, magnified; 3*b*, 3*c*, avicularia.

„ 4.—*Retepora simplex*, ... 118
4*a*, magnified.

„ 5.—*Cellepora ovalis* (Pl. XXXV. fig. 6), ... 202
5*a*, magnified.

„ 6.—*Cellepora aspera* (Pl. XXXV. fig. 2), ... 194
6*a*, magnified; 6*b*, avicularium.

„ 7.—*Cellepora rudis* (Pl. XXXVI. fig. 7), ... 199
7*a*, magnified; 7*b*, œcium; 7*c*, avicularium.

„ 8.—*Cellepora pustulata*, ... 200
8*a*, orifice;[2] 8*b*, orifice with avicularia; 8*c*, magnified; 8*d*, avicularium.

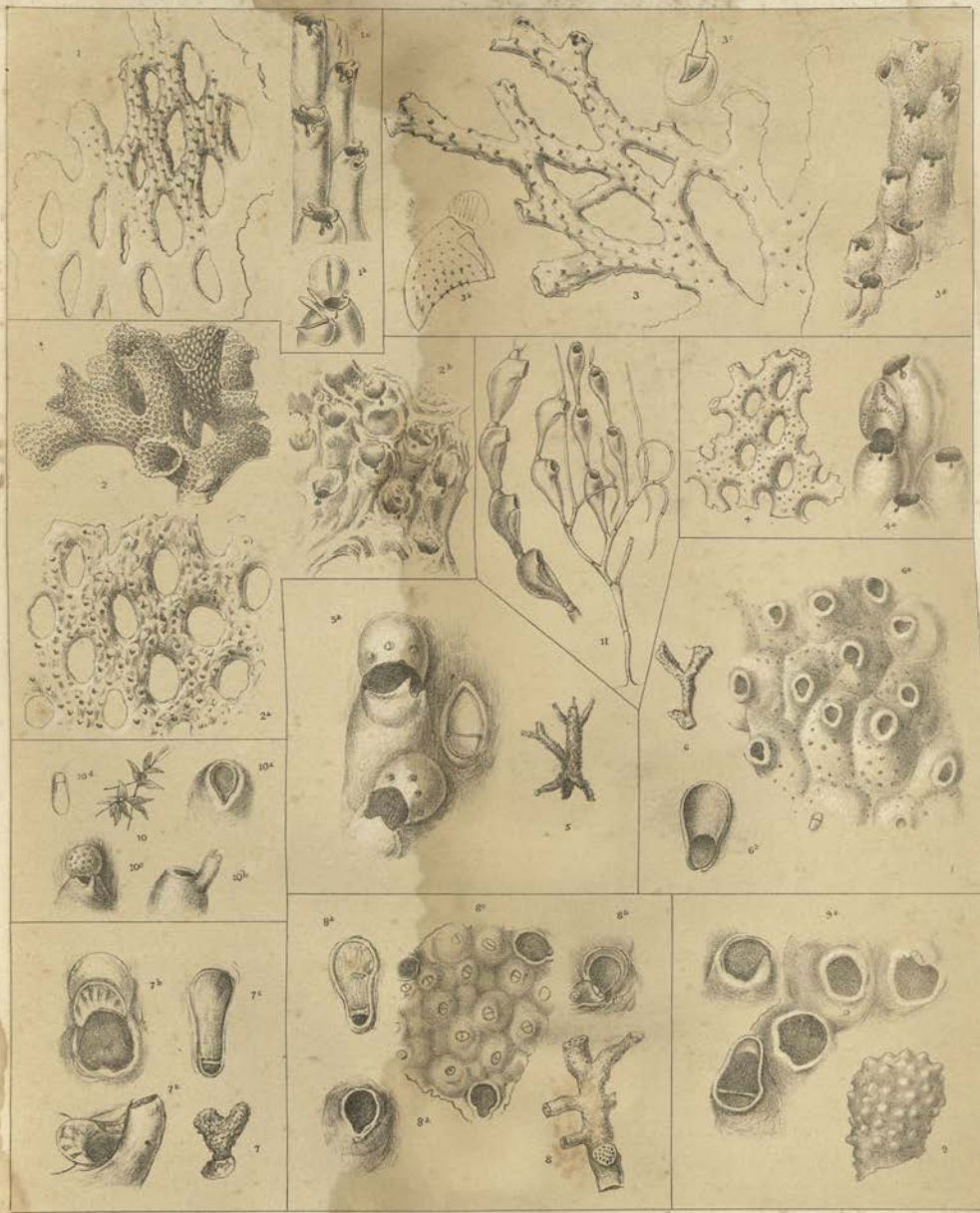
„ 9.—*Cellepora tuberculata* (Pl. XXXV. fig. 7), ... 193
9*a*, magnified.

„ 10.—*Cellepora conica*, also (Pl. XXXVI. fig. 1),* 203
10*a*, orifice; 10*b*, avicularium; 10*c*, œcium; 10*d*, avicularium.

„ 11.—*Chlidonia cordieri*, ... 8

[1] The species thus marked (*) have been re-named since the plate was printed off.

[2] 8*a* is the bottom left-hand figure.



1. RETEPORA CELLULOSA
2. " TUBULATA
3. " PUBENS
4. " SIMPLEX
5. CELLEPORA OVALIS
6. " SIMONENSIS
7. " RUDIS
8. CELLEPORA PUSTULATA
9. " TUBERCULATA
10. " CONICA
11. CHLIDONIA CORDIERI.

PLATE XXIX.

PLATE XXIX.

CELLEPORA.

PAGE

Figure 1.—*Cellepora hastigera* (Pl. XXXV. fig. 8), ... 192
1*a*, avicularium; 1*b*, avicularium with obtuse mandible and bifid beak.

„ 2.—*Cellepora apiculata* (Pl. XXXV. fig. 12), ... 196

„ 3.—*Cellepora tridenticulata* (Pl. XXXV. fig. 17), . . . 198
3*a*, orifice with oral spines; 3*b*, avicularium.

„ 4, 6, 8.—*Cellepora eatonensis* (Pl. XXXVI. fig. 5), ... 201
4*a*, 4*b*, avicularia; 6*a*, orifice enlarged; 6*b*, part view of orifice; 6*c*, 6*d*, avicularia; 8*a*, front view of orifice; 8*b*, avicularium; 8*c*, one of the interspersed avicularia.

„ 5.—*Cellepora honolulensis* (Pl. XXXV. fig. 15), . . . 195

„ 7.—*Cellepora imbellis* (Pl. XXXV. fig. 20), ... 195

„ 9.—*Cellepora simonensis* (Pl. XXXVI. fig. 8), ... 200
9*a*, operculum.

„ 10.—*Cellepora vagans* (Pl. XXXV. fig. 11), ... 198
10*a*, zoœcium; 10*b*, avicularium; 10*c*, 10*d*, larger avicularia; 10*e*, operculum.

„ 11.—*Cellepora columnaris* (Pl. XXXV. fig. 16), . . . 194

„ 12.—*Cellepora solida*, ... 200
12*a*, operculum.

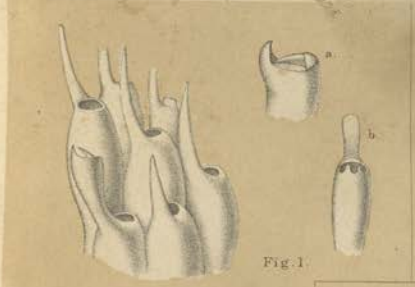


Fig. 1.

Fig. 2.

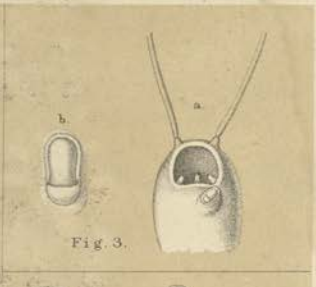


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

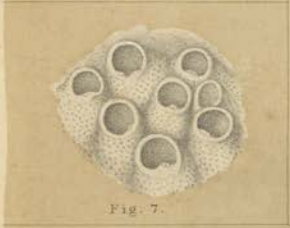


Fig. 7.

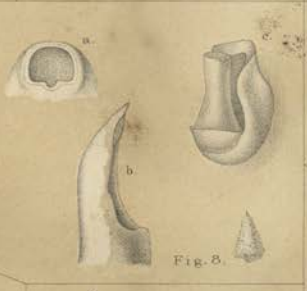


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

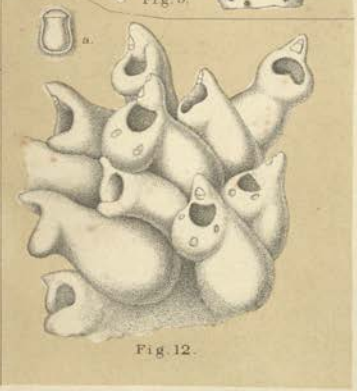


Fig. 12.

G.B. del. C. Berjeau lith. Mintern Bros. Imp.

1. CELLEPORA HASTIGERA. 2. C. APICULATA. 3. C. TRIDENTICULATA.
4. C. EATONENSIS. 5. C. HONOLULENSIS. 6. C. EATONENSIS. 7. C. IMBELLIS.
8. C. EATONENSIS. 9. C. SIMONENSIS. 10. C. VAGANS. 11. C. COLUMNARIS. 12. C. SOLIDA.

PLATE XXX.

PLATE XXX.

CELLEPORA.

PAGE

Figures 1, 12.—*Cellepora bicornis* (Pl. XXXVI. figs. 13, 15), . . . 202
12*a*, orifice; 12*b*, side view; 12*c*, oœcium; 12*d*, avicularium.

„ 2.—*Cellepora bilabiata*, ... 203
2*a*, 2*b*, zoœcia; 2*c*, oœcia; all magnified.

„ 3.—*Cellepora signata* (Pl. XXXVI. fig. 14), . . . 203
3*a*, zoœcia; 3*b*, orifice; 3*c*, oœcium; 3*d*, avicularium.

„ 4.—*Cellepora ansata* (Pl. XXXVI. fig. 17), . . . 204
4*a*, orifice of zoœcium and avicularium; 4*b*, side view.

„ 5.—*Cellepora canaliculata* (Pl. XXXVI. fig. 16), . . . 204
5*a*, front view; 5*b*, side view of orifice.

„ 6.—*Cellepora bidenticulata* (Pl. XXXVI. fig. 6), . . . 204
6*a*, orifice; 6*b*, orifice with zoœcium.

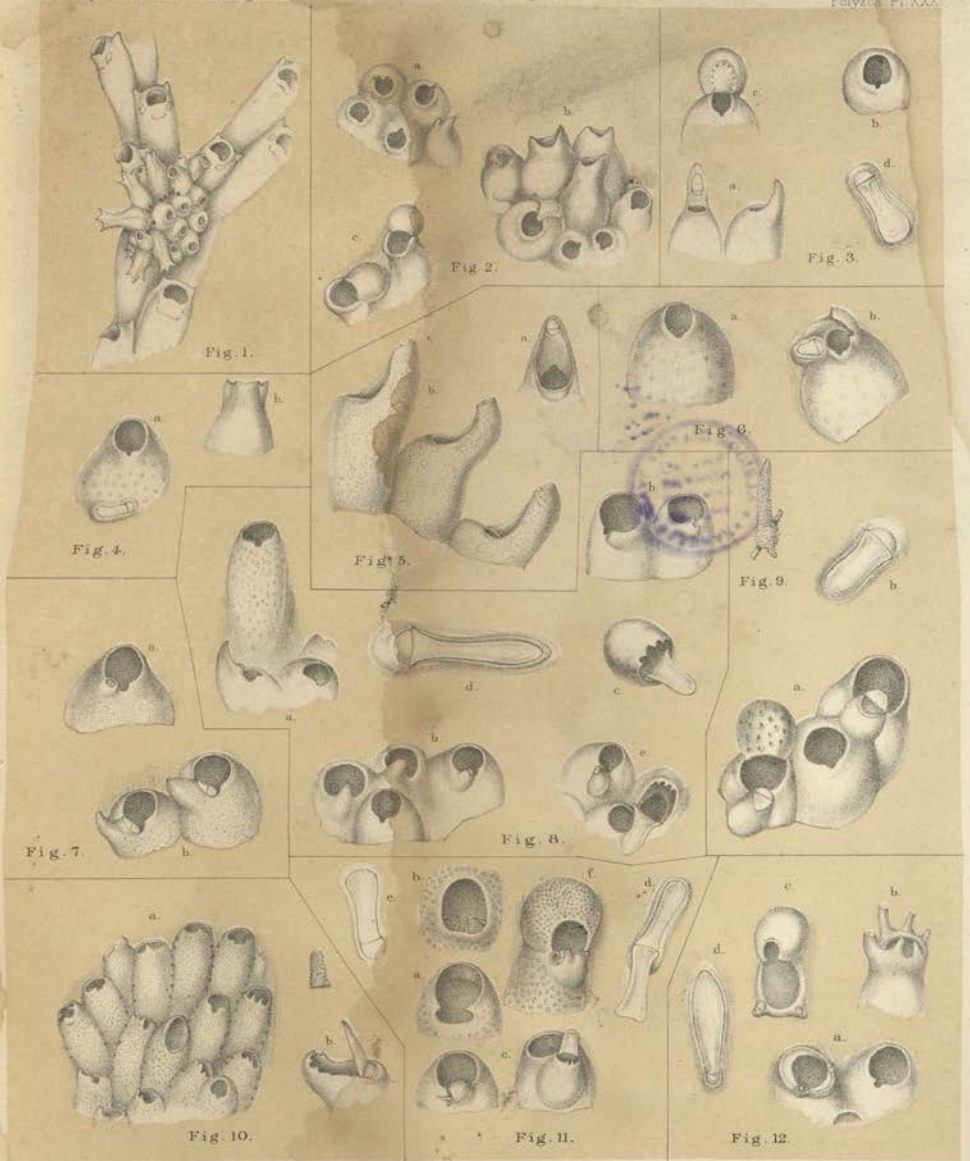
„ 7.—*Cellepora samboangensis* (Pl. XXXV. fig. 10), . . . 196

„ 8.—*Cellepora discoidea* (Pl. XXXV. fig. 1), . . . 197
8*a*, zoœcia; 8*b*, orifices; 8*c*, 8*d*, 8*e*, avicularia.

„ 9.—*Cellepora cylindriformis* (Pl. XXXVI. fig. 9), . . . 201
9*a*, orifice with oœcium; 9*b*, avicularium.

„ 10.—*Cellepora jacksoniensis* (Pl. XXXV. fig. 9), . . . 195
10*a*, magnified; 10*b*, avicularium.

„ 11.—*Cellepora polymorpha* (Pl. XXXV. fig. 19), . . . 195
11*a*, orifice; 11*b*, side view; 11*c*, oœcium; 11*d*, avicularium.



G.B. del. C.Berjeau lith. Mintern Bros. imp.

1. CELLEPORA BICORNIS. 2. C. BILABIATA. 3. C. SIGNATA. 4. C. ANSATA.
5. C. CANALICULATA. 6. C. BIDENTICULATA. 7. C. ZAMBOANGENSIS. 8. C. DISCOIDEA.
9. C. CYLINDRIFORMIS. 10. C. JACKSONIENSIS. 11. C. POLYMORPHA. 12. C. BICORNIS.

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PLATE XXXI.

PLATE XXXI.

Farciminaria.—Bugula.

PAGE

Figure 1.—*Farciminaria magna*, var. *armata*, ... 50

„ 2.—*Farciminaria brasiliensis*, ... 50
2*a*, magnified; 2*b*, oœcium, more highly magnified.

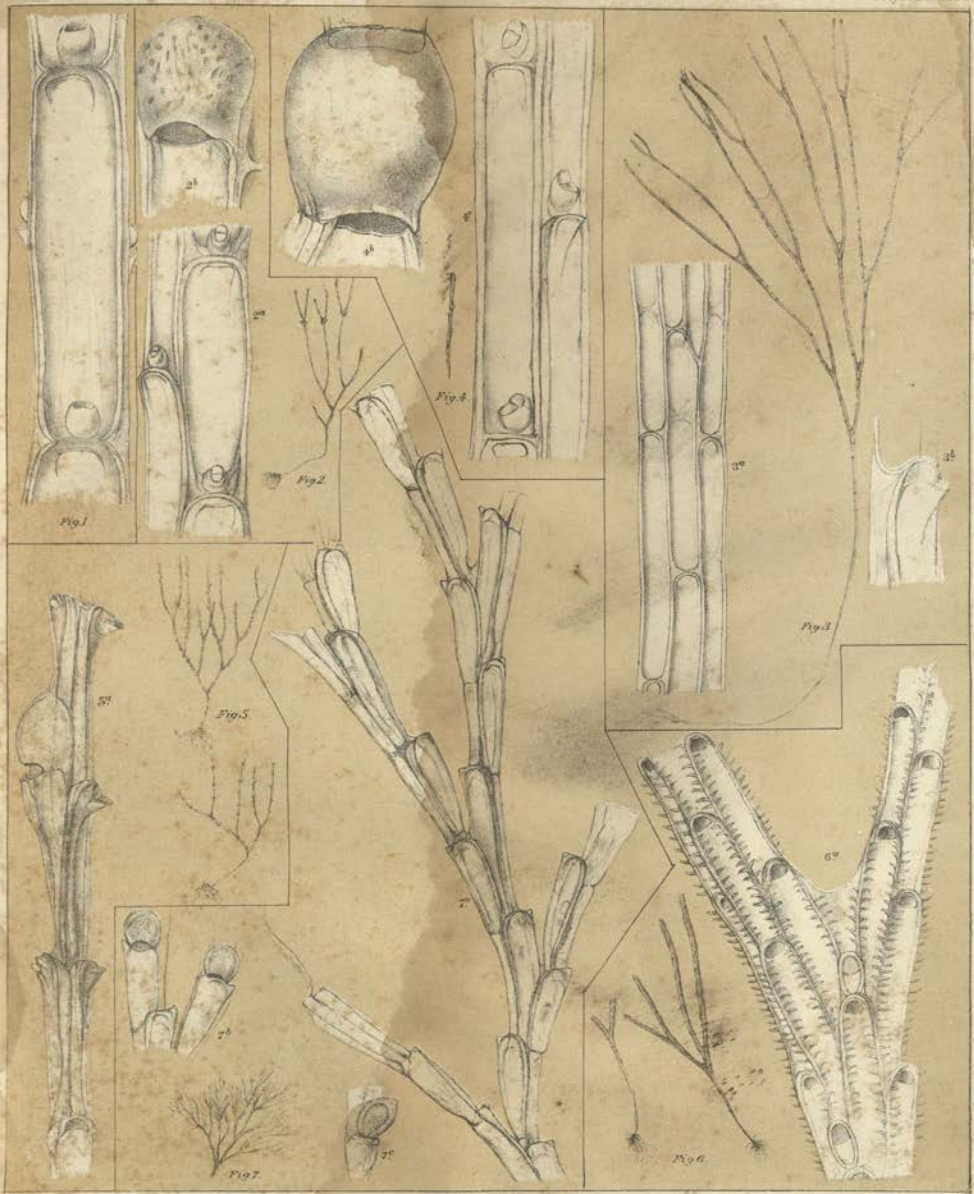
„ 3.—*Farciminaria hexagona* (Pl. XIV. fig. 10), ... 51
3*a*, magnified; 3*b*, orifice, more highly magnified.

„ 4.—*Farciminaria pacifica*, ... 50
4*a*, magnified; 4*b*, oœcium, more highly magnified.

„ 5.—*Farciminaria delicatissima*, ... 51
5*a*, magnified.

„ 6.—*Farciminaria atlantica*, ... 49
6*a*, magnified.

„ 7.—*Bugula longissima*, ... 42
7*a*, magnified; 7*b*, 7*c*, oœcia.



G. Gibbs del. & J. Wertheim lith. Hanhart imp.

1. FARCIMINARIA MAGNA var. ARMATA. 2. F. BRASILIENSIS. 3. F. HEXAGONA.
4. F. PACIFICA. 5. F. DELICATISSIMA. 6. F. ATLANTICA. 7. BUGULA LONGISSIMA.

PLATE XXXII

PLATE XXXII.

BICELLARIA.—FLUSTRA.—CALYMMOPHORA.—CABEREA.

PAGE

Figure 1.—*Bicellaria macilenta*, ... 35
1*a*, natural size; 1*b*, magnified; 1*c*, more highly magnified; 1*d*, back view.

„ 2.—*Flustra denticulata*, ... 53
2*a*, natural size; 2*b*, magnified.

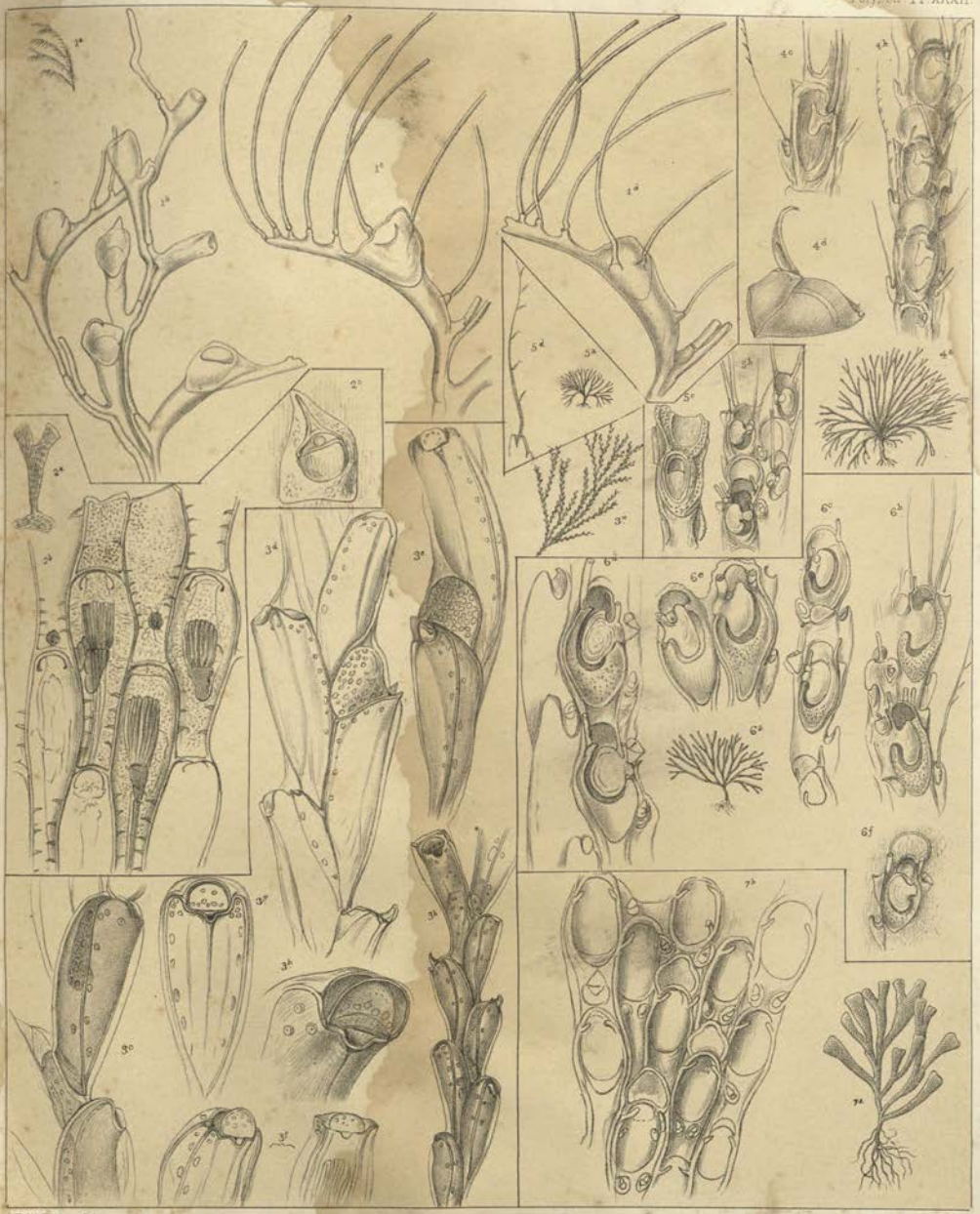
„ 3.—*Calymmophora lucida*, ... 83
3*a*, natural size; 3*b*, 3*c*, magnified; 3*d*, 3*e*, oœcia; 3*f*, 3*g*, 3*h*, orifice with oral valve.

„ 4.—*Caberea rostrata*, ... 28
4*a*, natural size; 4*b*, with oœcia, magnified; 4*c*, a single zoœcium; 4*d*, large rostriform avicularium.

„ 5.—*Caberea minima*, ... 30
5*a*, natural size; 5*b*, 5*c*, magnified; 5*d*, peduncular spine, magnified.

„ 6.—*Caberea darwinii*, ... 29
6*a*, natural size; 6*b*, 6*c*, magnified; 6*d*, 6*e*, more highly magnified; 6*f*, oœcium.

„ 7.—*Flustra membraniporides*, ... 54
7*a*, natural size; 7*b*, magnified.



G.B. del. Purkiss lith.

Hanhart imp.

1. BICELLARIA MACILENTA.
2. FLUSTRA DENTICULATA.
3. CALYMOPHORA LUCIDA.
4. CABEREA ROSTRATA.
5. " MINIMA.
6. " DARWINII.
7. FLUSTRA MEMBRANIPORIDES.

PLATE XXXIII.

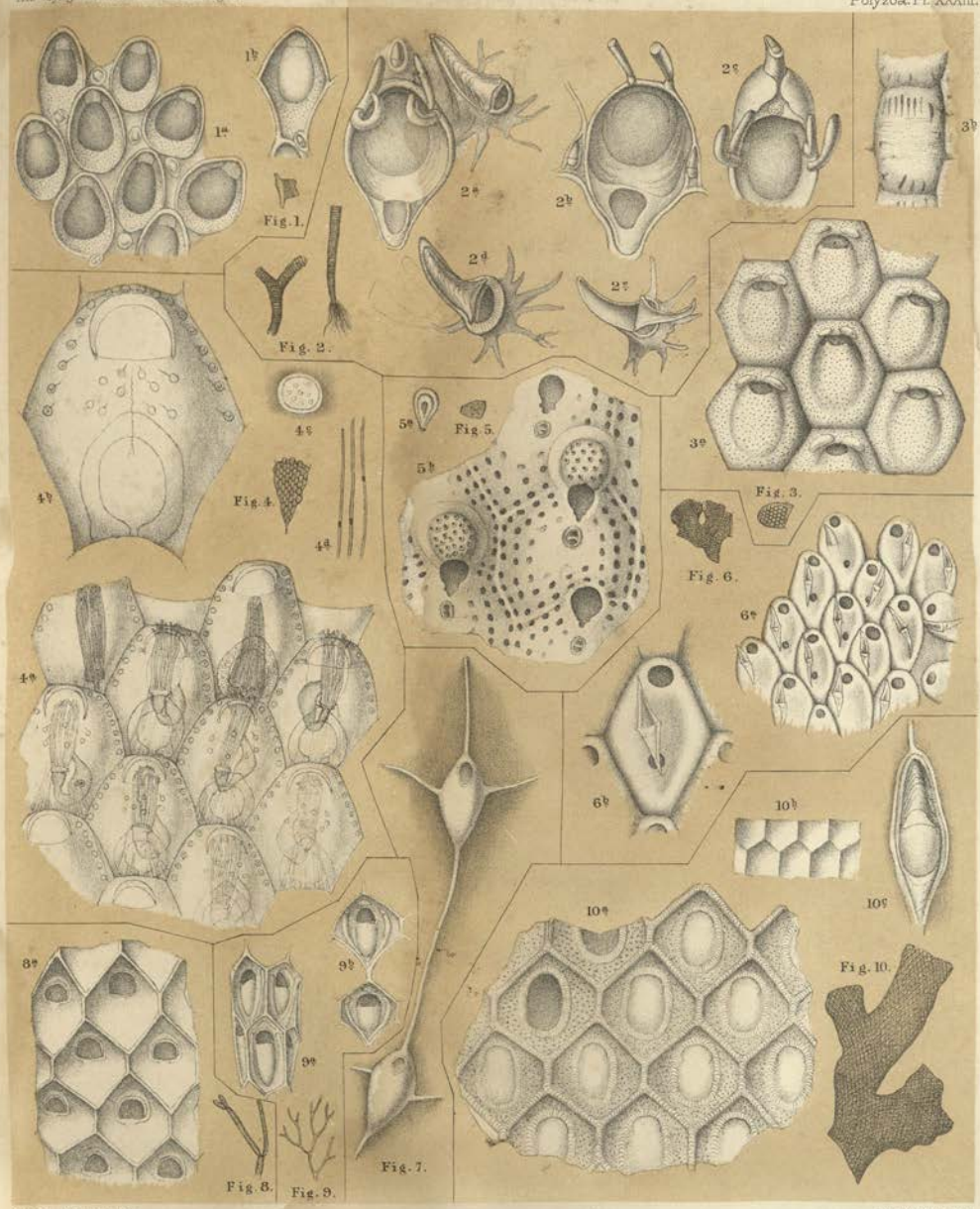
PLATE XXXIII.[1]

AMPHIBLESTRUM.—ELECTRA.—ASPIDOSTOMA.—CARBASEA, &c.

		PAGE
Figure	1.—*Amphiblestrum papillatum,** . . . . . 1*a*, magnified; 1*b*, with avicularium.	66
,,	2.—*Electra cylindracea,*[2] . . . . . 2*a*, 2*b*, aperture with chitinous spines and avicularium; 2*c*, oœcium; 2*d*, 2*e*, upright process with large avicularium and chitinous appendages.	78
,,	3.—*Aspidostoma giganteum,* . . . . . 3*a*, magnified; 3*b*, back view.	161
,,	4.—*Carbasea moseleyi,* . . . . . 4*a*, magnified; 4*b*, more highly magnified, showing horse shoe mark; 4c, interzoœcial pore; 4*d*, retractor muscles.	56
,,	5.—*Gemmellipora cribritheca,** . . . . . 5*a*, operculum; 5*b*, magnified with oœcia.	176
,, 6, 6*a*, *b*.	—*Adeona appendiculata,**	181
,,	7.—*Hippothoa flagellum,*	4
,,	8.—*Salicornaria simplex,* . . . . . 8*a*, magnified.	88
,,	9.—*Salicornaria bicornis,* . . . . . 9*a*, 9*b*, magnified zoœcia.	90
,,	10.—*Melicerita dubia,** . . . . . 10*a*, magnified; 10*b*, transverse section; 10*c*, vicarious avicularium.	97

[1] The species thus marked (*) have been re-named since the plate was printed off.

[2] See footnote on page 78 of text.



C.B. del. C. Berjeau lith.

Mintern Bros., imp.

1. MEMBRANIPORA PAPILLATA. 2. ELECTRA CYLINDRICA. 3. ASPIDOSTOMA GIGANTEA.
4. CARBASEA MOSELEYI. 5. LEPRALIA CRIBRITHECA. 6. ADEONA GRISEA.
7. HIPPOTHOA FLAGELLUM. 8. SALICORNARIA SIMPLEX. 9. S. BICORNIS. 10. VINCULARIA RHOMBICA.

PLATE XXXIV.

PLATE XXXIV.

PASYTHEA.—GEPHYROPHORA.—BRETTIA.—DIACHORIS, &c.

PAGE

Figure 1.—*Pasythea eburnea*, ... 5
1*a*, magnified; 1*b*, 1*f*, erect zoœcia; 1*c*, adnate zoœcium; 1*d*, zoœcia with radical tubes; 1*e*, punctum, more highly magnified.

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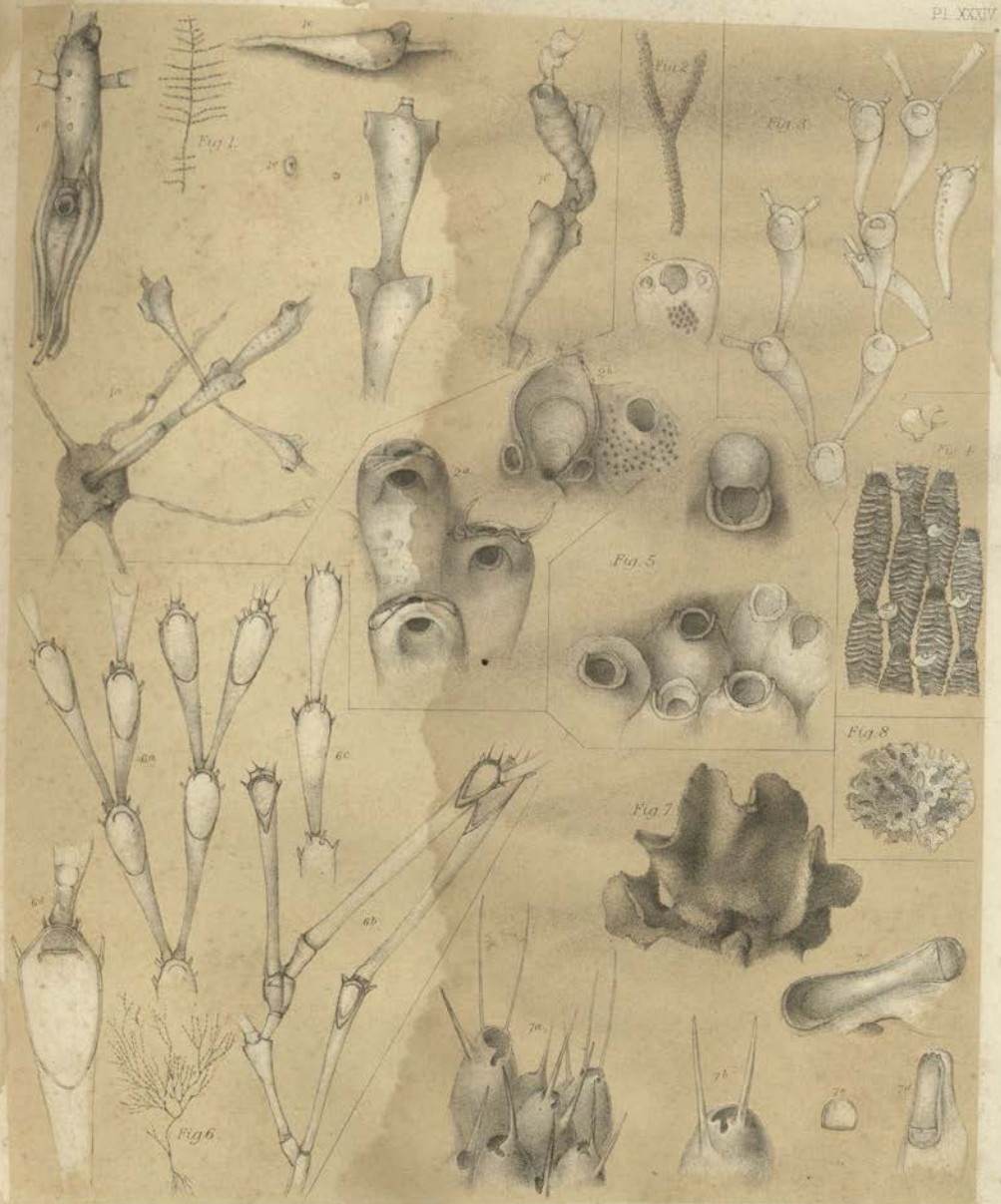

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1. PASYTHEA EBURNEA. 2. GEPHYROPHORA POLYMORPHA. 3. BRETTIA AUSTRALIS.
4. DIACHORIS COSTATA. 5. PHYLACTELLA SP ? 6. " CORNIGERA.
7. CELLEPORA ALBIROSTRIS. 8. CARBASEA CRIBRIFORMIS.

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PLATE XXXV.

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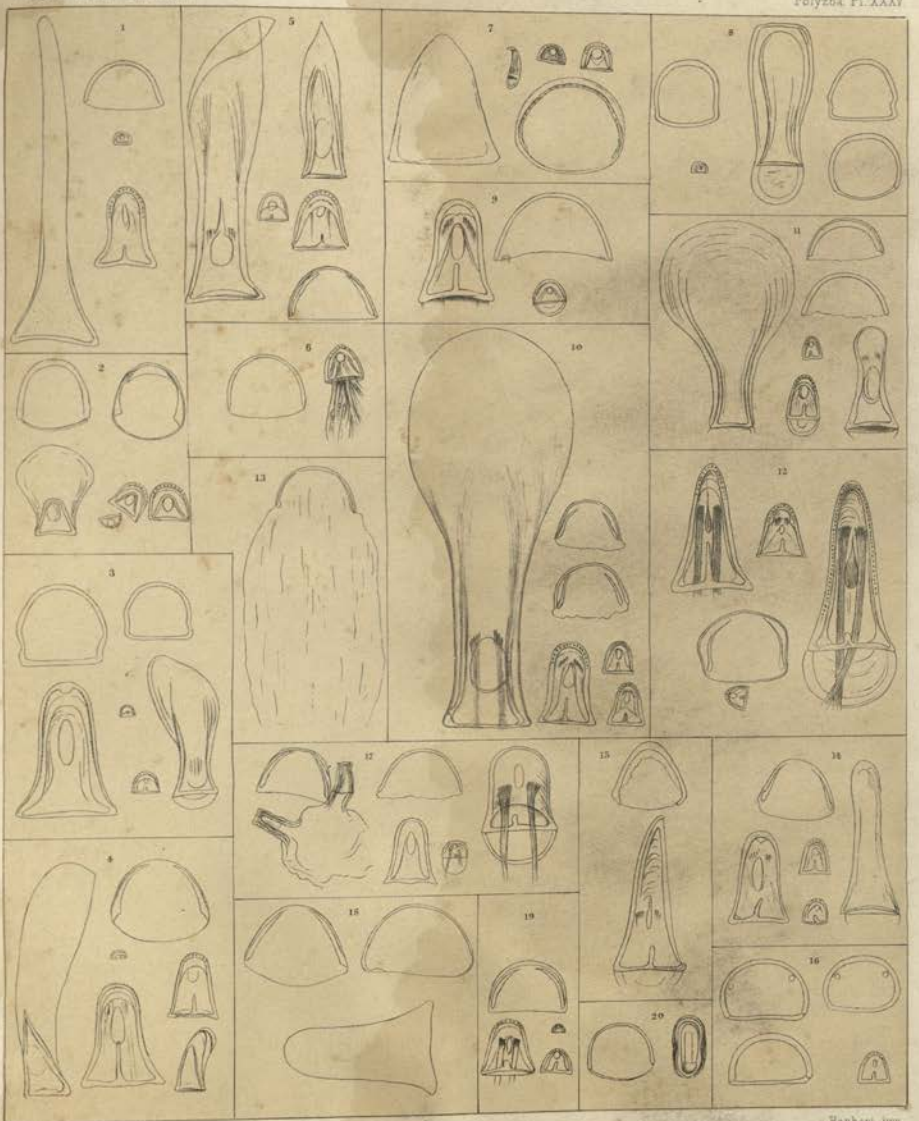

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Hanhart imp.

CHITINOUS APPENDAGES OF SPECIES OF CELLEPORA.

PLATE XXXVI.

PLATE XXXVI.

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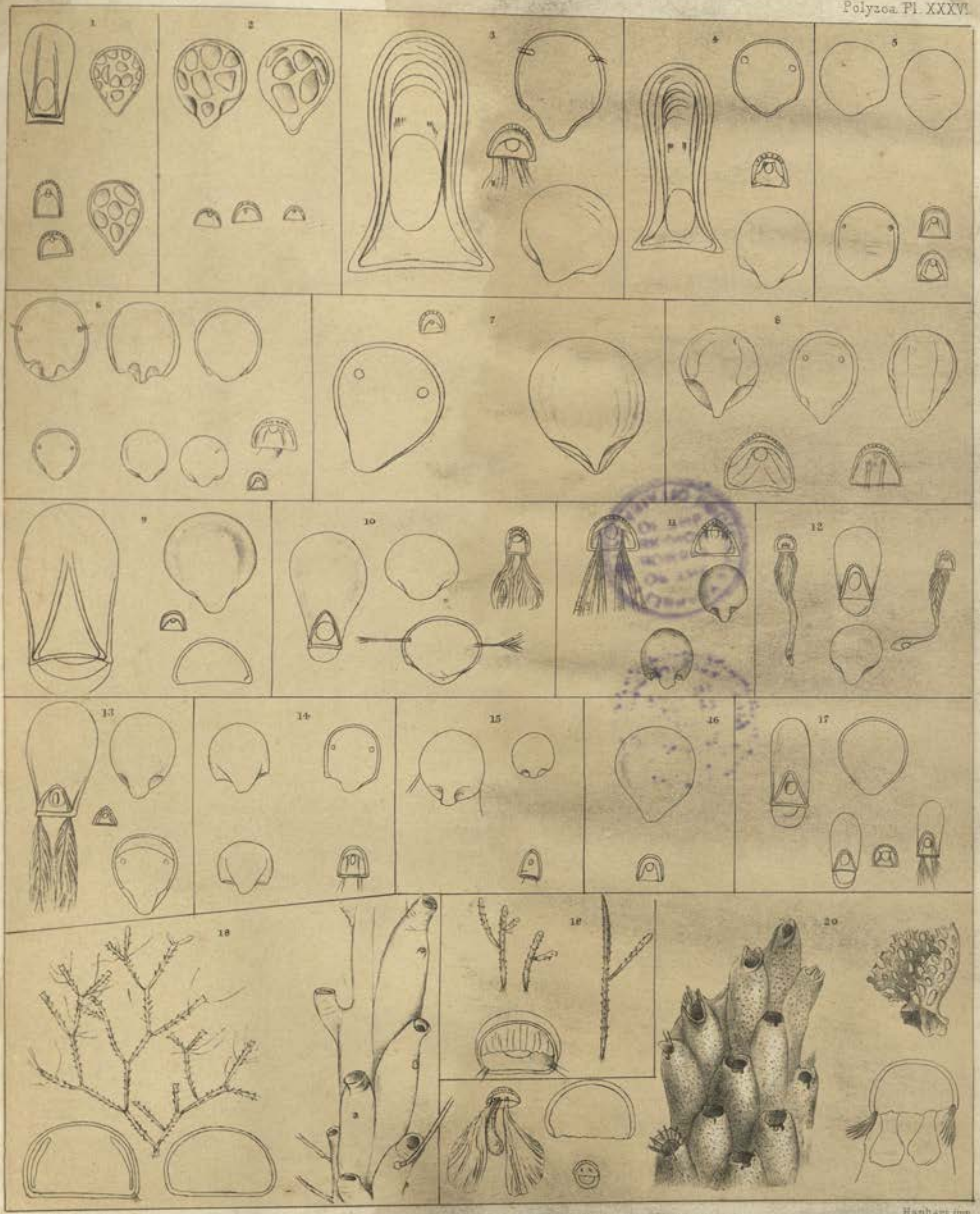

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1.17. CHITINOUS APPENDAGES OF SPECIES OF CELLEPORA.
18. TUBUCELLARIA.
19. " CEREOIDES.
20. RETEPORA MAGELLENSIS.

Voyage of H.M.S. "Challenger."
Polyzoa.
A
B
C
D
E
F
G
TRACK OF
H.M.S. CHALLENGER
Decr. 1872 to May 1876.
Showing the Dredging and Trawling Stations.
Engraved by Malby & Sons.

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